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Feder et al.

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(54) **SYSTEM, METHOD, AND COMPUTER PROGRAM PRODUCT FOR EXCHANGING IMAGES**

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G06F 17/30 (2006.01)
G06K 9/46 (2006.01)
G06T 5/00 (2006.01)

(52) **U.S. Cl.**

CPC ***G06F 17/30247*** (2013.01); ***G06F 17/3028*** (2013.01); ***G06K 9/46*** (2013.01); ***G06T 5/00*** (2013.01)

(58) **Field of Classification Search**

CPC G06T 5/00; G06T 1/00; G06T 2200/24; G06T 2207/20092; G06T 2219/2012; G06F 17/30247; G06F 17/3028; G06K 9/46

See application file for complete search history.

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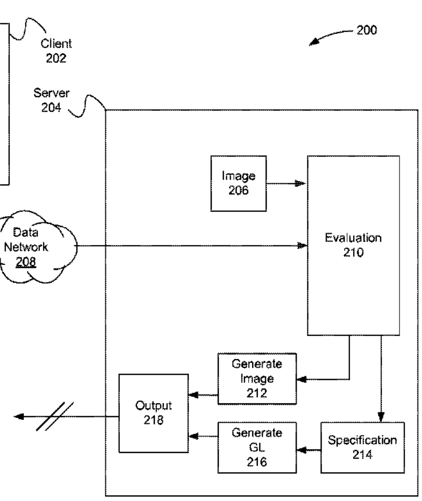
(57) **ABSTRACT**

A system, method, and computer program product are provided for exchanging images. In use, one or more images are received at a server. Additionally, the one or more images are analyzed. Further, image processing code is outputted referencing the one or more images, based on the analysis of the one or more images. Additional systems, methods, and computer program products are also presented.

20 Claims, 17 Drawing Sheets



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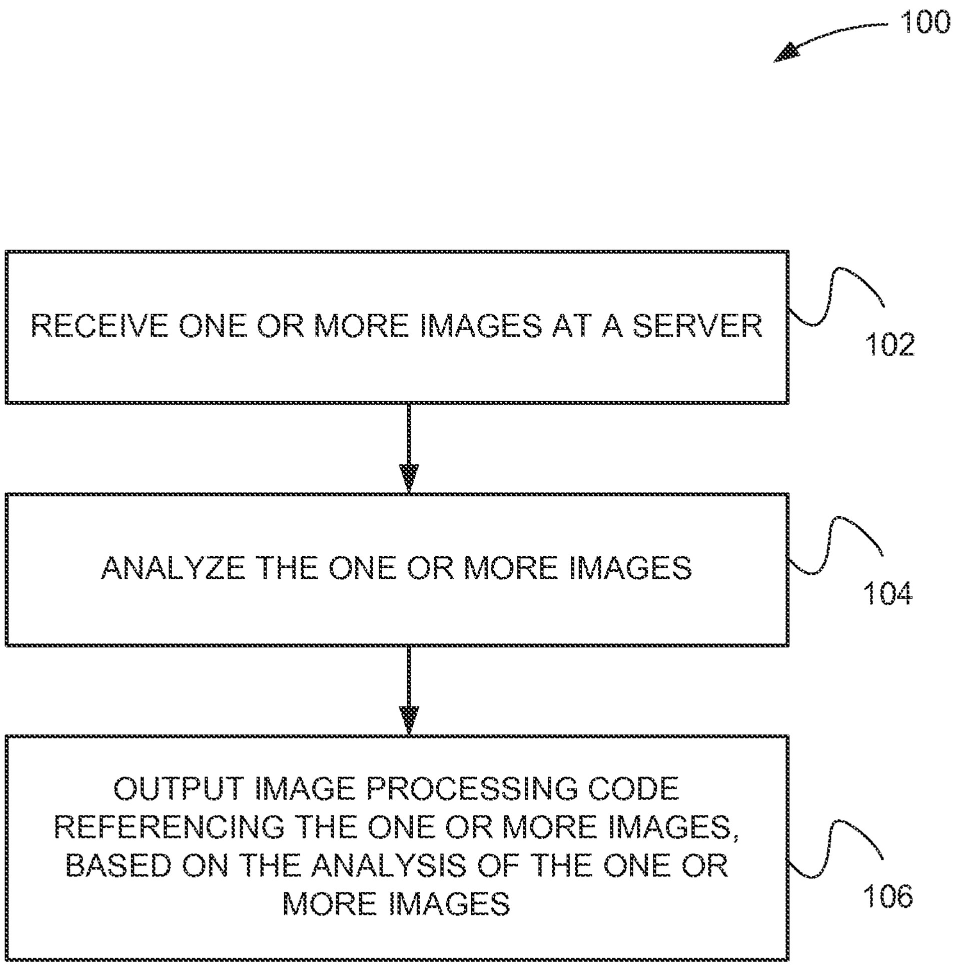

100
RECEIVE ONE OR MORE IMAGES AT A SERVER
102
ANALYZE THE ONE OR MORE IMAGES
104
OUTPUT IMAGE PROCESSING CODE REFERENCING THE ONE OR MORE IMAGES, BASED ON THE ANALYSIS OF THE ONE OR MORE IMAGES
106

Figure 1

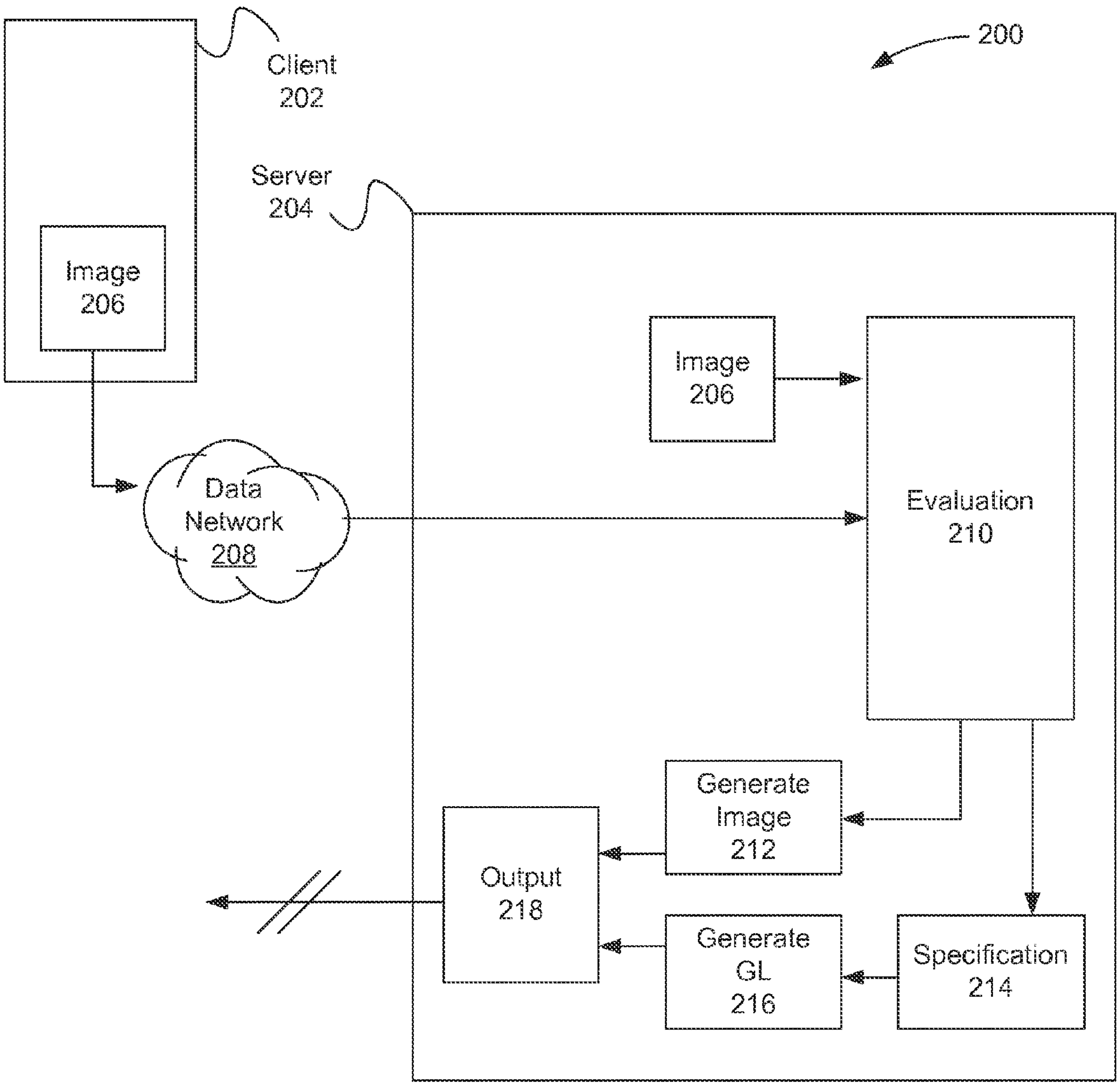
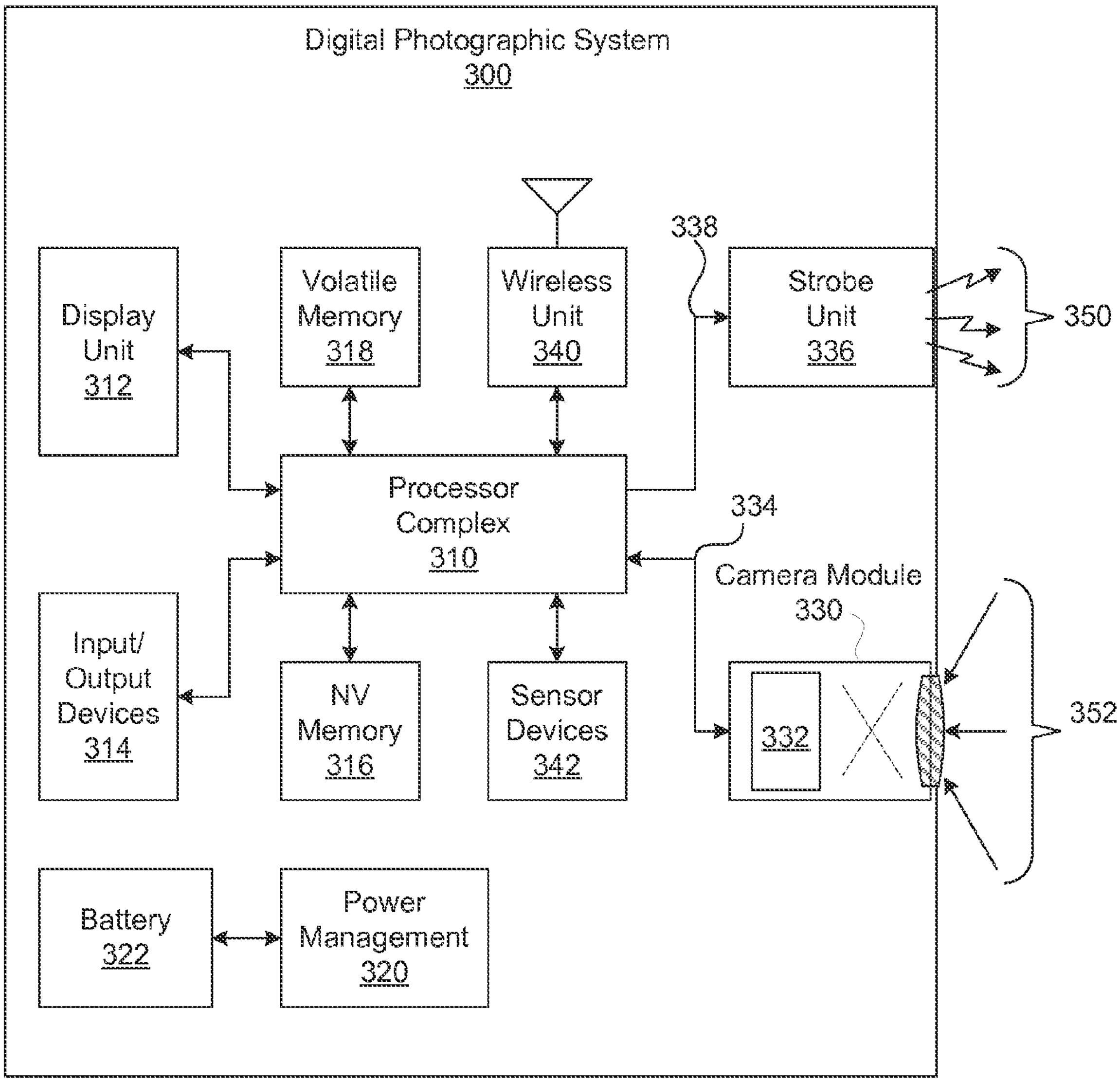

200
Client
202
Image
206
Server
204
Data
Network
208
Image
206
Evaluation
210
Generate
Image
212
Output
218
Generate
GL
216
Specification
214

Figure 2



Digital Photographic System
300
Display
Unit
312
Volatile
Memory
318
Wireless
Unit
340
338
Strobe
Unit
336
350
Processor
Complex
310
334
Camera Module
330
Input/
Output
Devices
314
NV
Memory
316
Sensor
Devices
342
332
352
Battery
322
Power
Management
320

Figure 3A

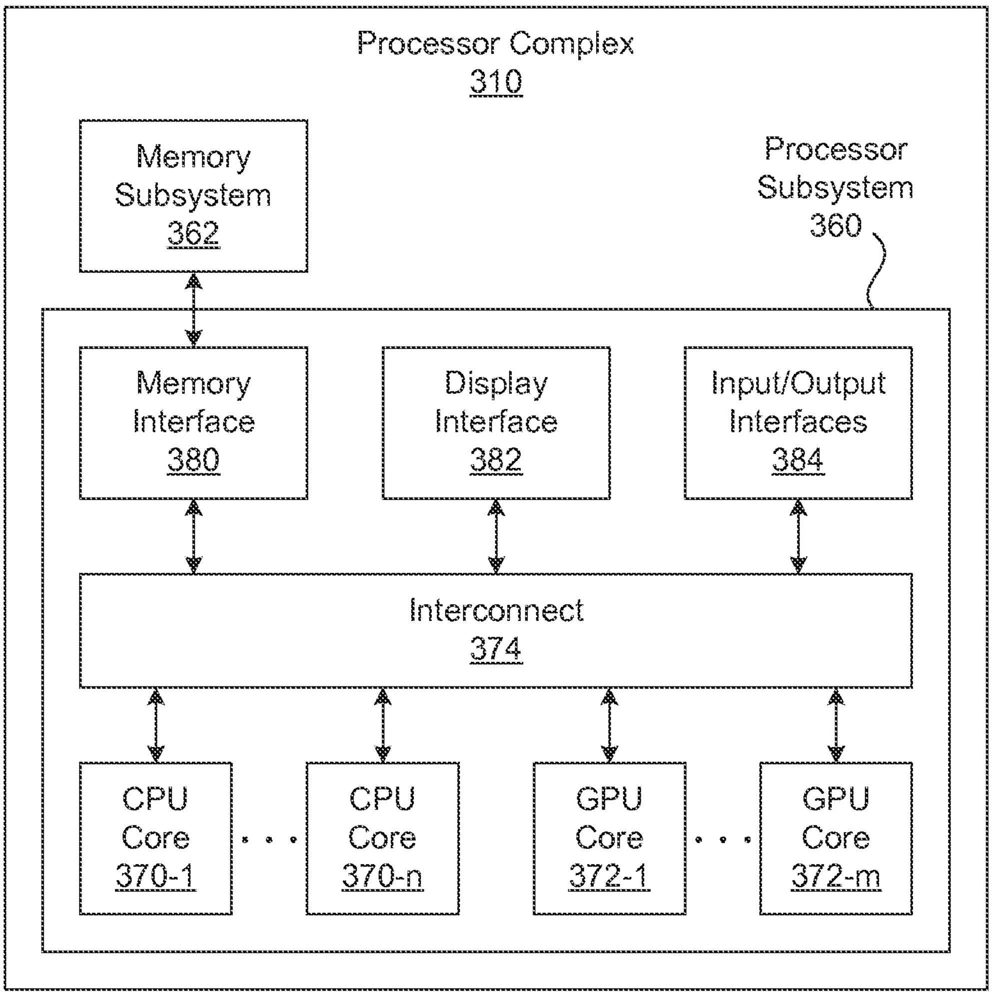

Processor Complex
310
Memory
Subsystem
362
Processor
Subsystem
360
Memory
Interface
380
Display
Interface
382
Input/Output
Interfaces
384
Interconnect
374
CPU
Core
370-1
CPU
Core
370-n
GPU
Core
372-1
GPU
Core
372-m

Figure 3B

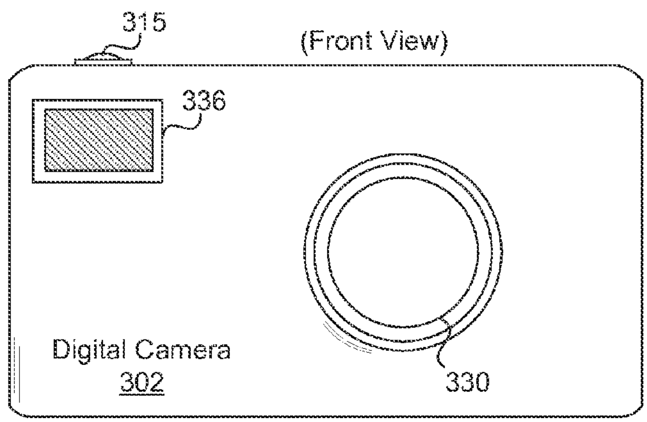


Figure 3C

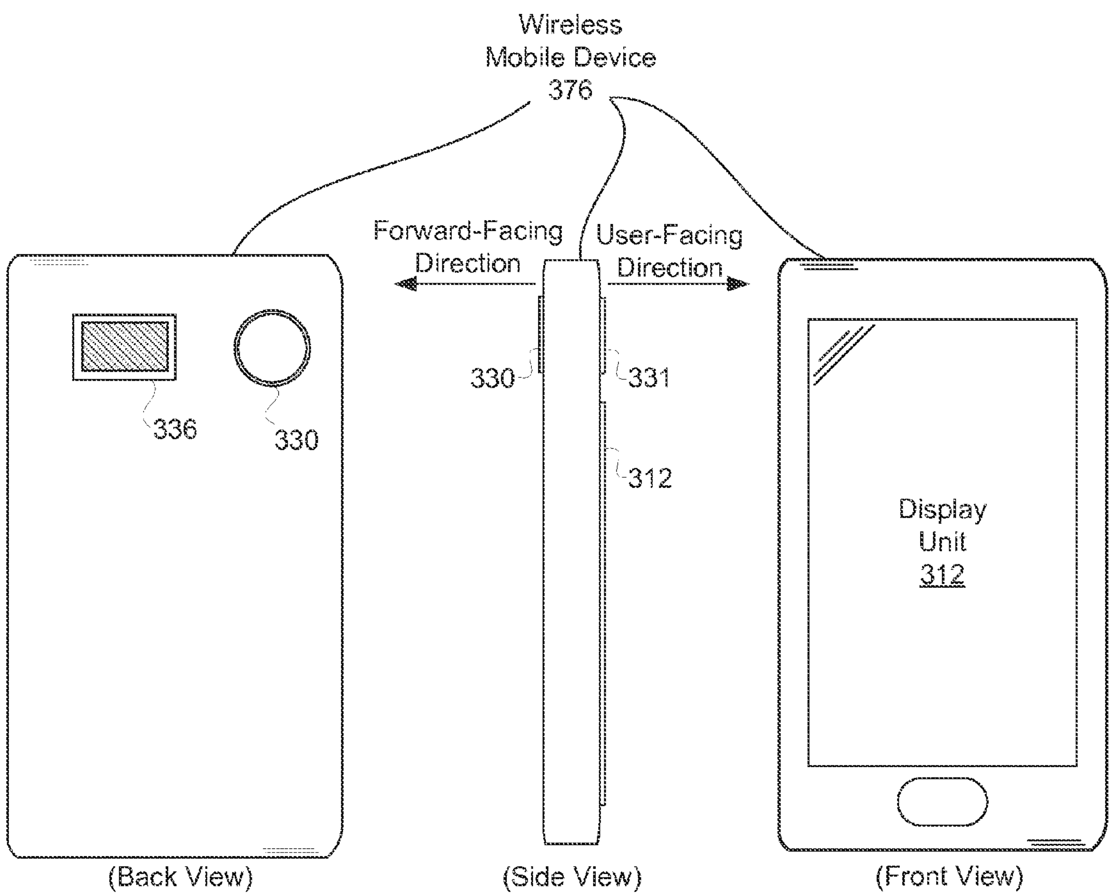


Figure 3D

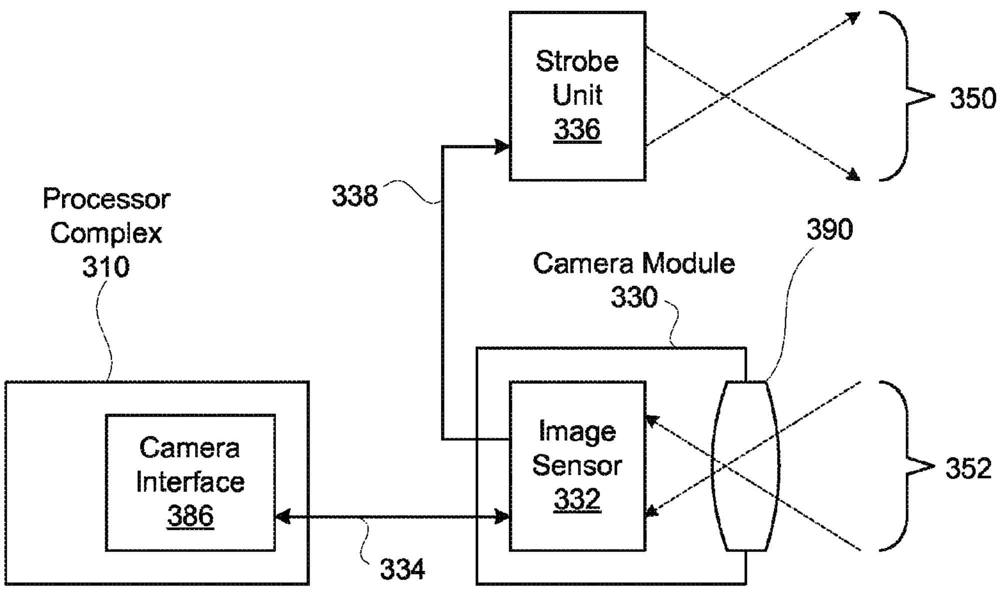


Figure 3E

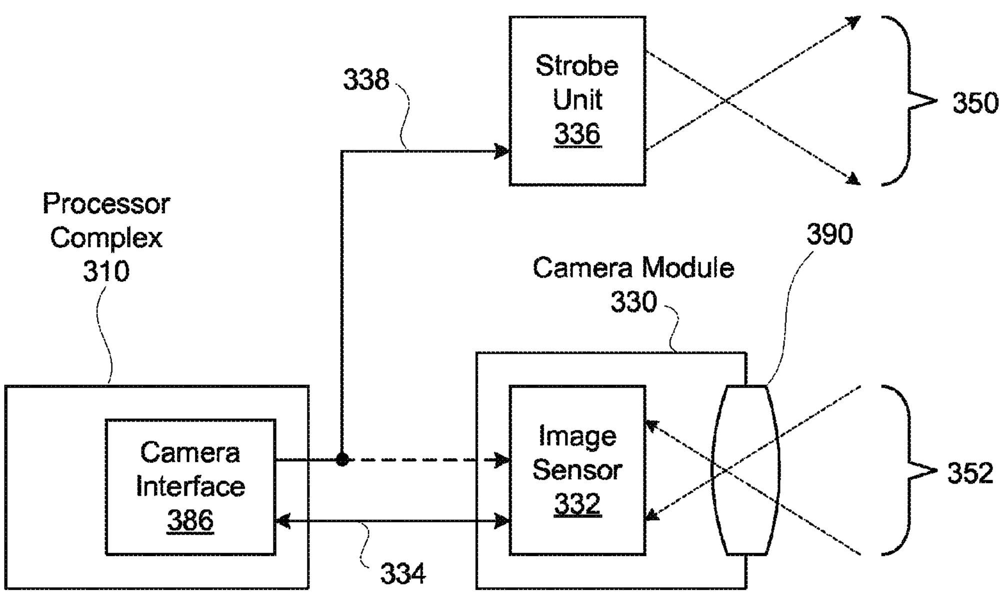


Figure 3F

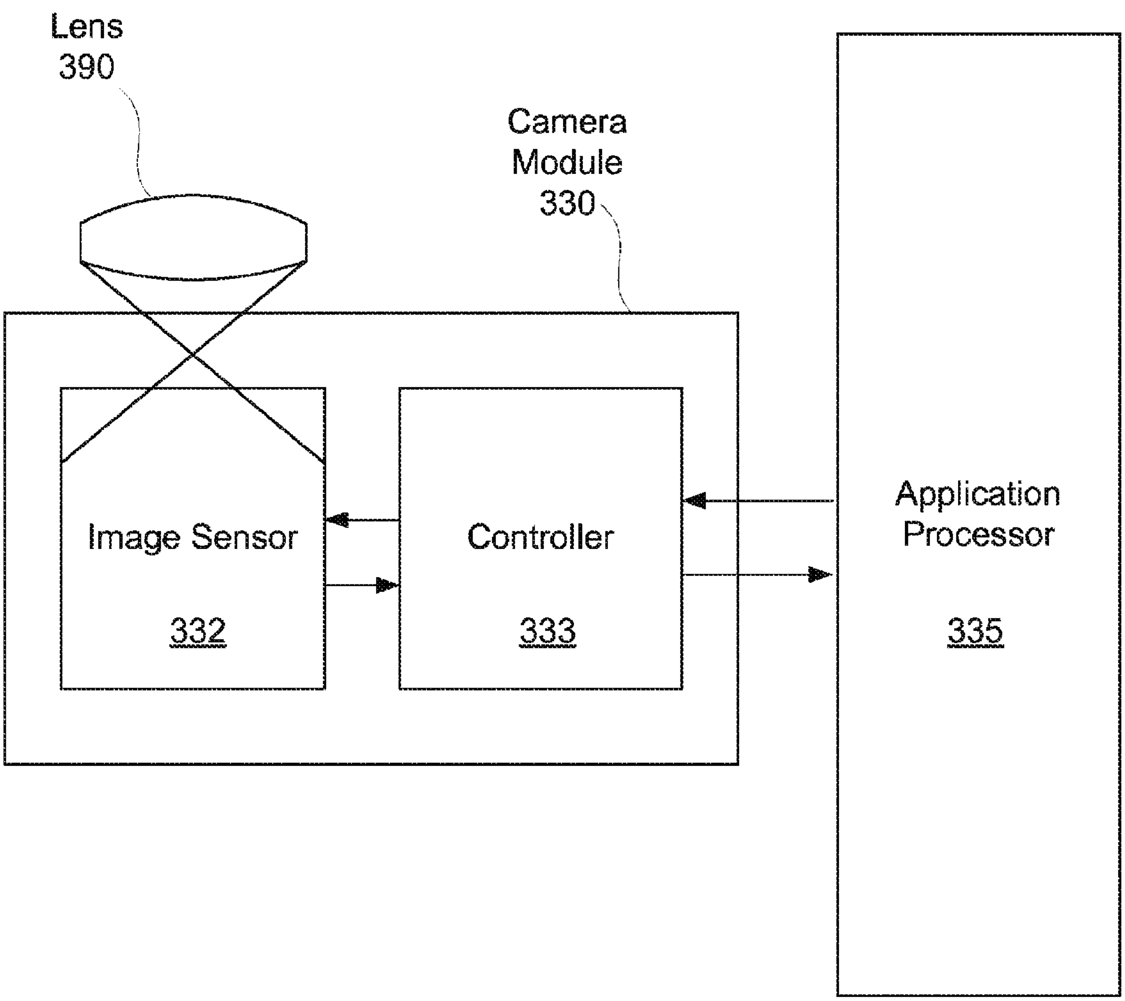

Lens
390
Camera
Module
330
Image Sensor
332
Controller
333
Application
Processor
335

Figure 3G

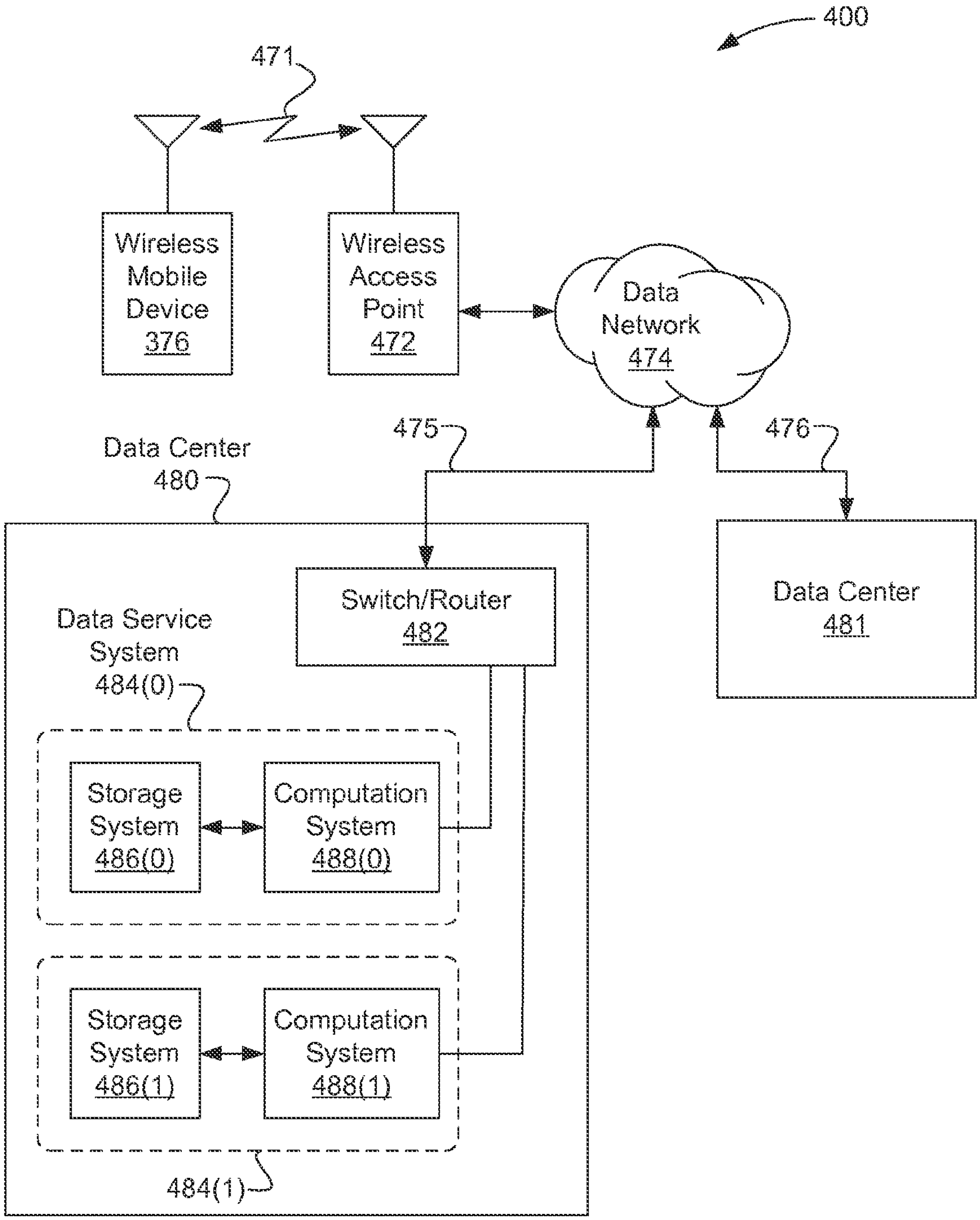

400
471
Wireless Mobile Device 376
Wireless Access Point 472
Data Network 474
475
476
Data Center 480
Switch/Router 482
Data Center 481
Data Service System 484(0)
Storage System 486(0)
Computation System 488(0)
Storage System 486(1)
Computation System 488(1)
484(1)

Figure 4

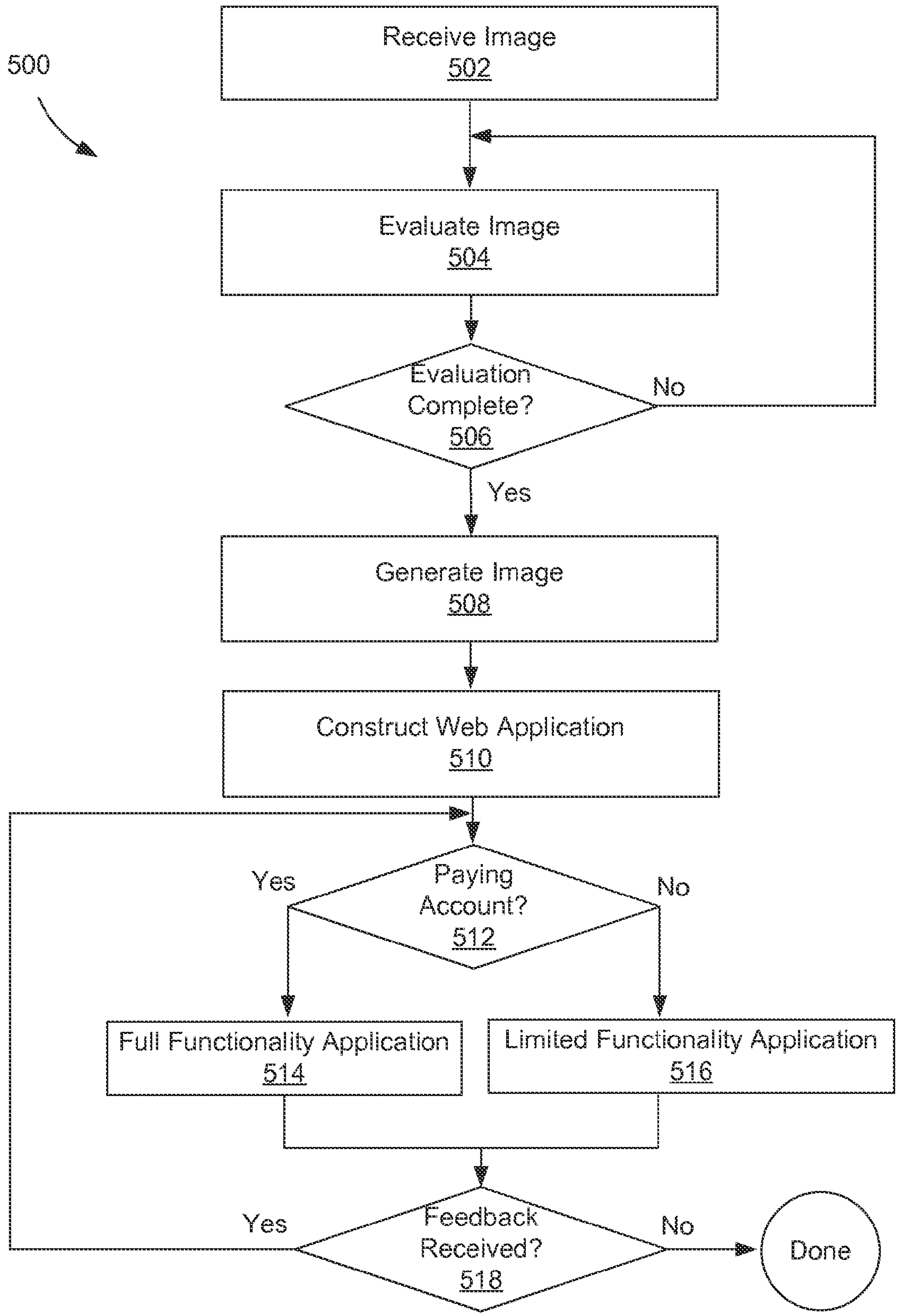

500
Receive Image
502
Evaluate Image
504
Evaluation Complete?
506
No
Yes
Generate Image
508
Construct Web Application
510
Paying Account?
512
Yes
No
Full Functionality Application
514
Limited Functionality Application
516
Feedback Received?
518
Yes
No
Done

Figure 5

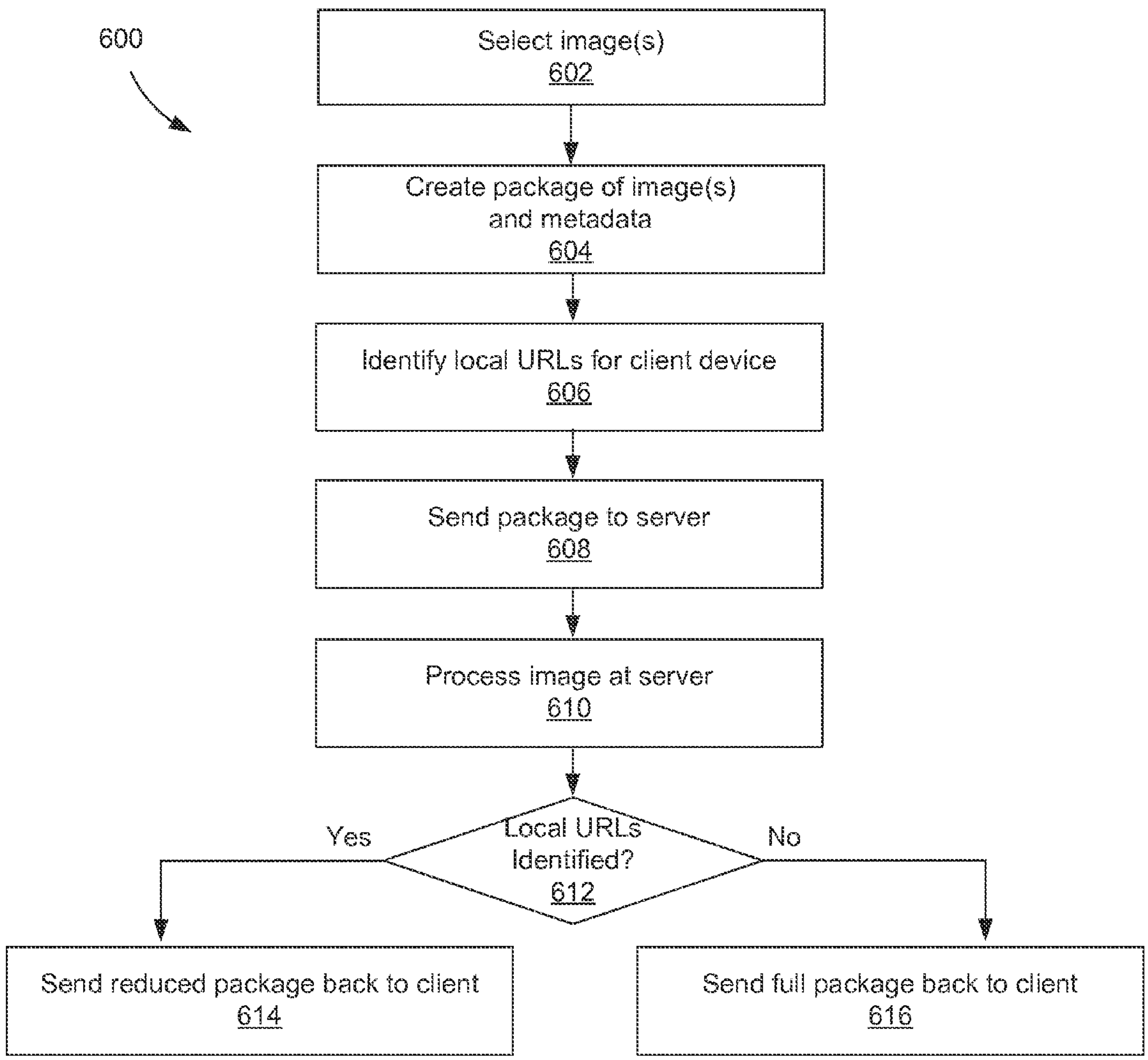

600
Select image(s)
602
Create package of image(s)
and metadata
604
Identify local URLs for client device
606
Send package to server
608
Process image at server
610
Local URLs
Identified?
612
Yes
No
Send reduced package back to client
614
Send full package back to client
616

Figure 6

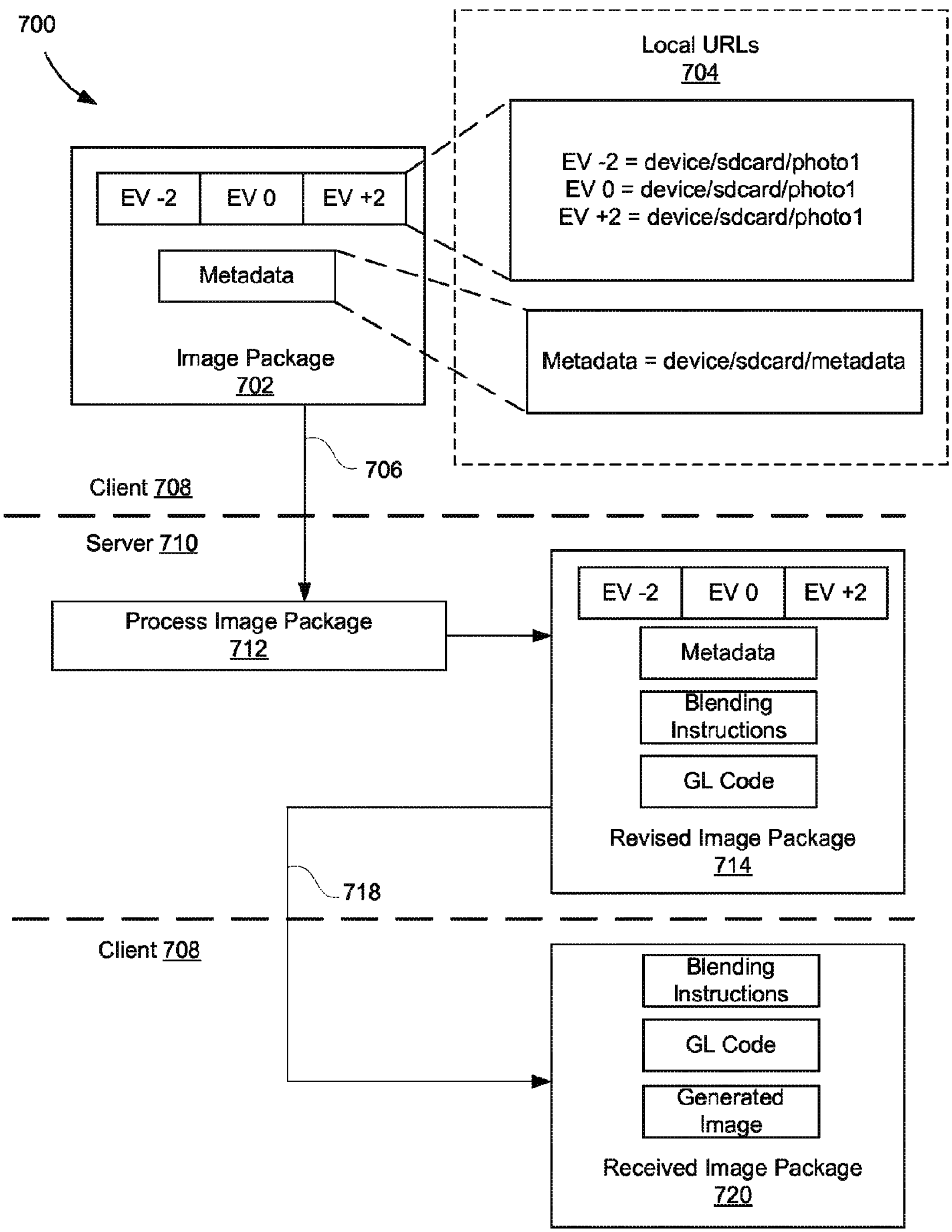

700
Local URLs
704
EV -2
EV 0
EV +2
EV -2 = device/sdcard/photo1
EV 0 = device/sdcard/photo1
EV +2 = device/sdcard/photo1
Metadata
Metadata = device/sdcard/metadata
Image Package
702
706
Client 708
Server 710
Process Image Package
712
EV -2
EV 0
EV +2
Metadata
Blending Instructions
GL Code
Revised Image Package
714
718
Client 708
Blending Instructions
GL Code
Generated Image
Received Image Package
720

Figure 7

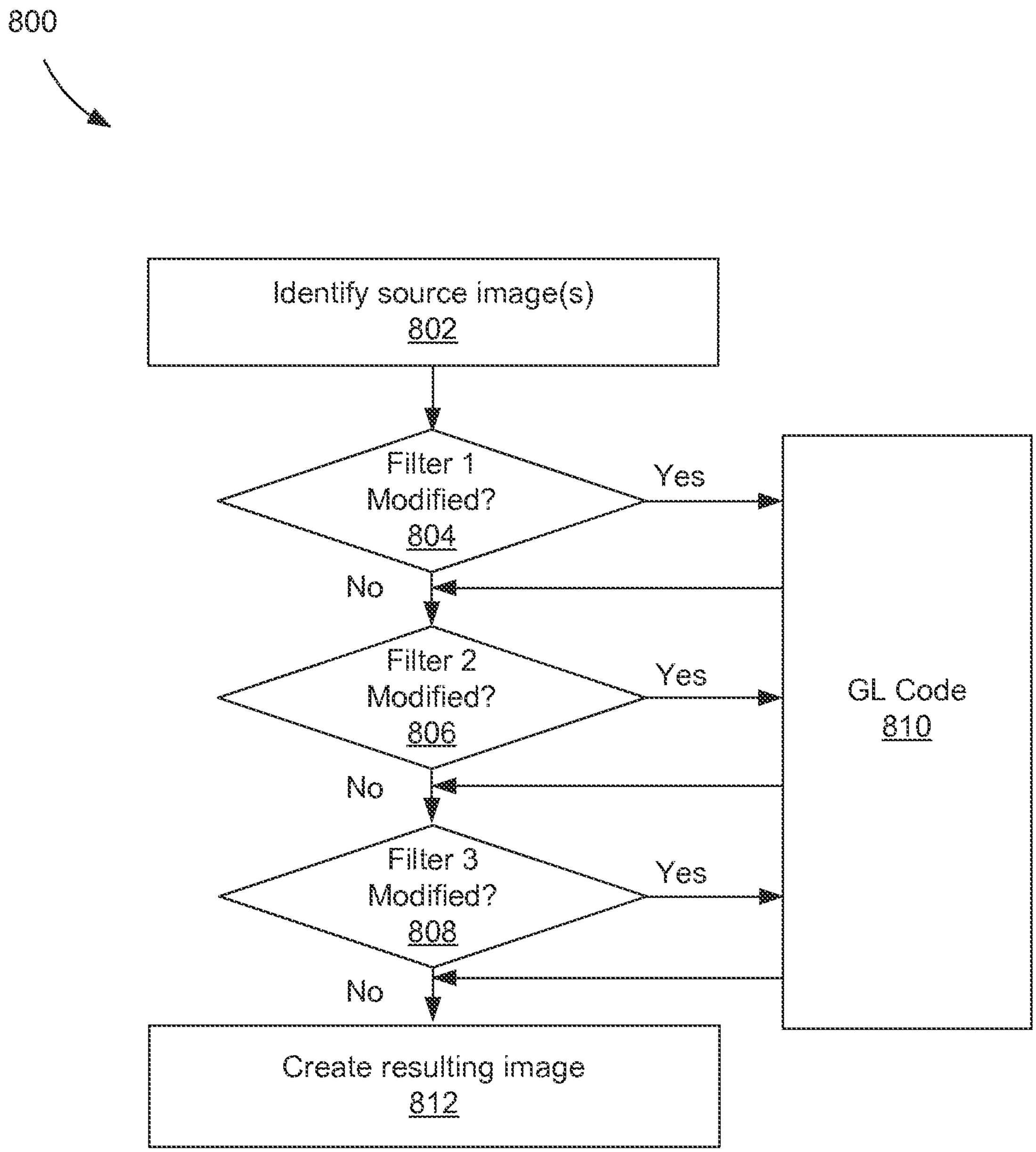

800
Identify source image(s)
802
Filter 1
Modified?
804
Yes
No
Filter 2
Modified?
806
Yes
No
Filter 3
Modified?
808
Yes
No
GL Code
810
Create resulting image
812

Figure 8

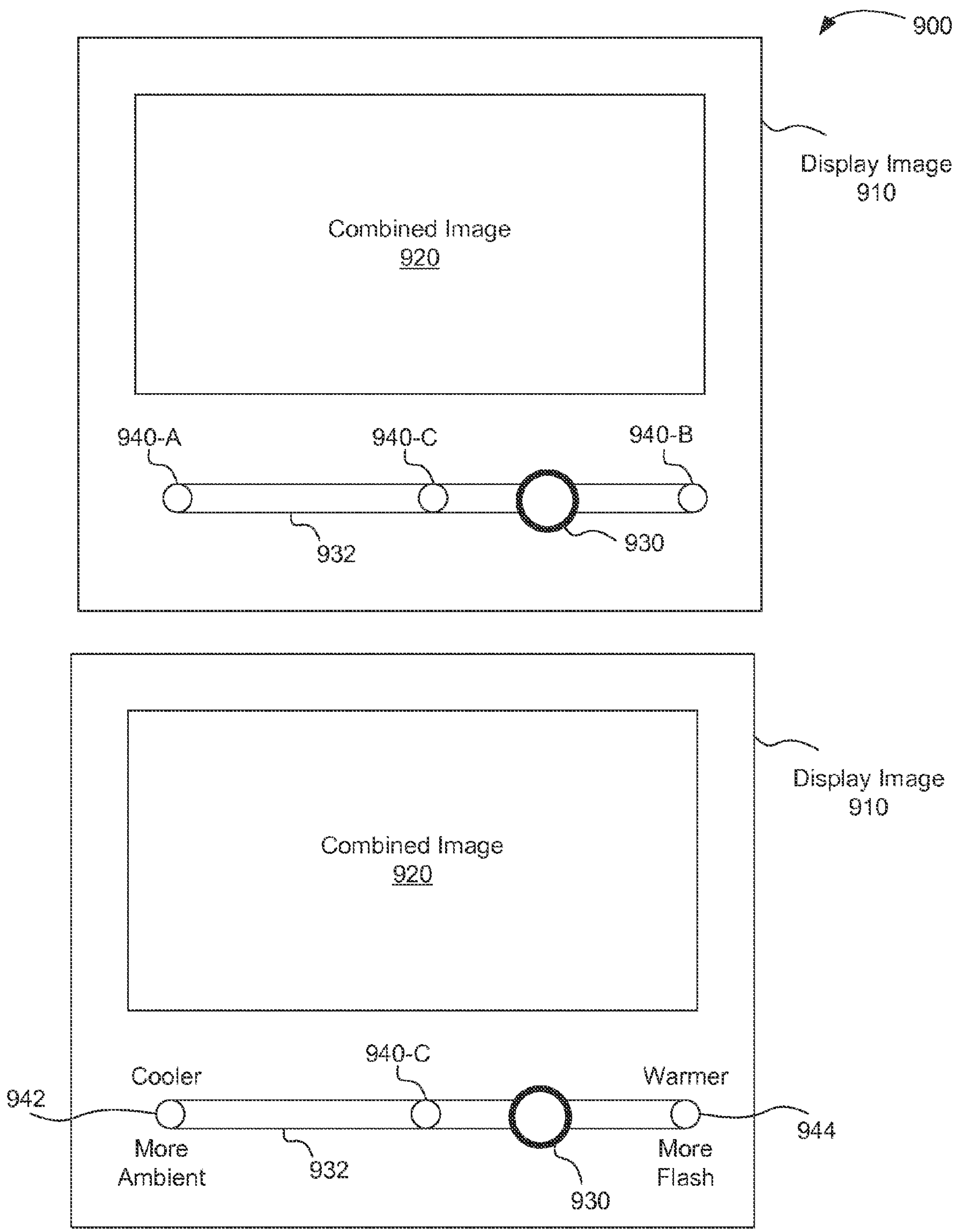

900
Display Image
910
Combined Image
920
940-A
940-C
940-B
932
930
Display Image
910
Combined Image
920
940-C
Cooler
Warmer
942
944
More
Ambient
932
930
More
Flash

Figure 9

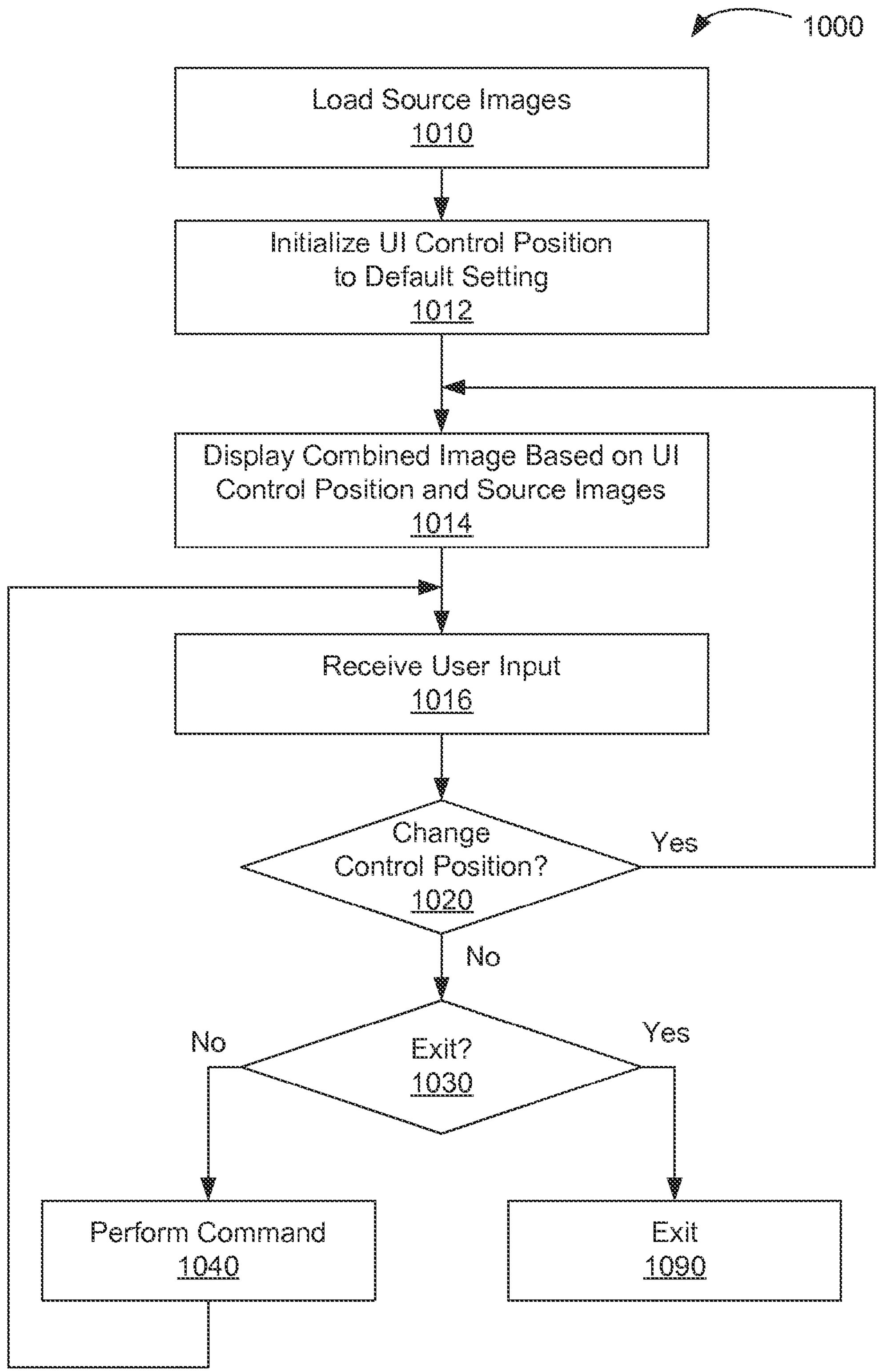

1000
Load Source Images
1010
Initialize UI Control Position
to Default Setting
1012
Display Combined Image Based on UI
Control Position and Source Images
1014
Receive User Input
1016
Change
Control Position?
1020
Yes
No
Exit?
1030
No
Yes
Perform Command
1040
Exit
1090

Figure 10

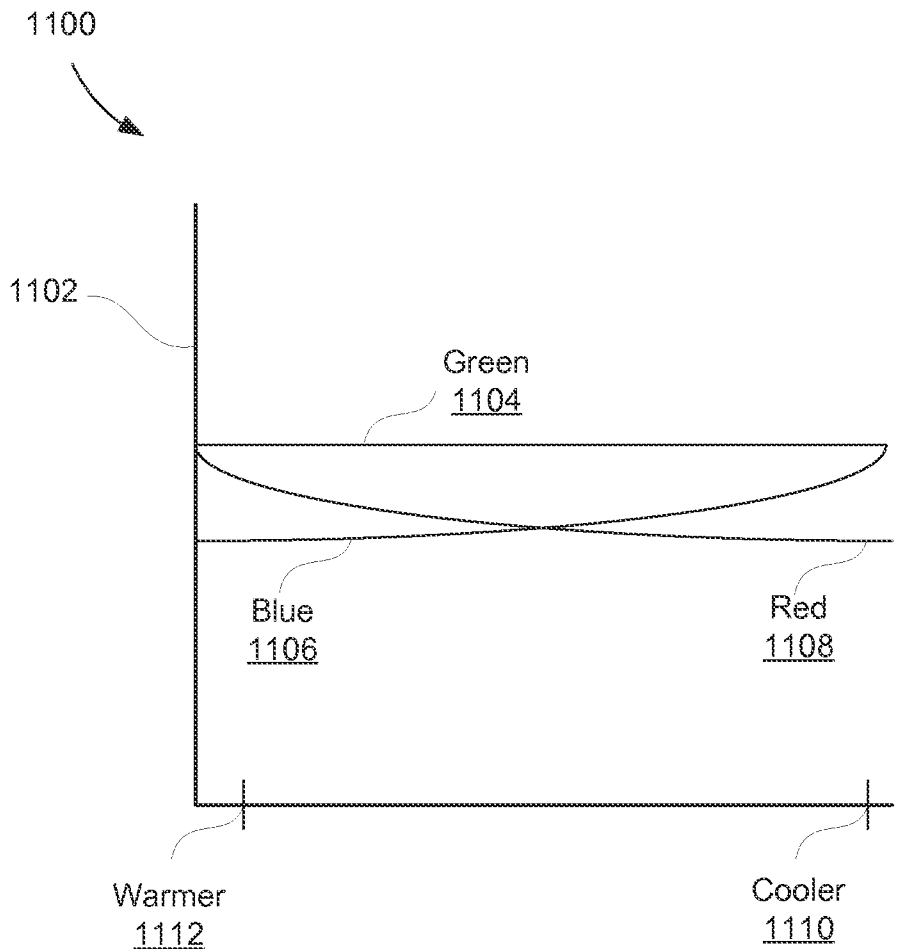

1100
1102
Green
1104
Blue
1106
Red
1108
Warmer
1112
Cooler
1110

Figure 11

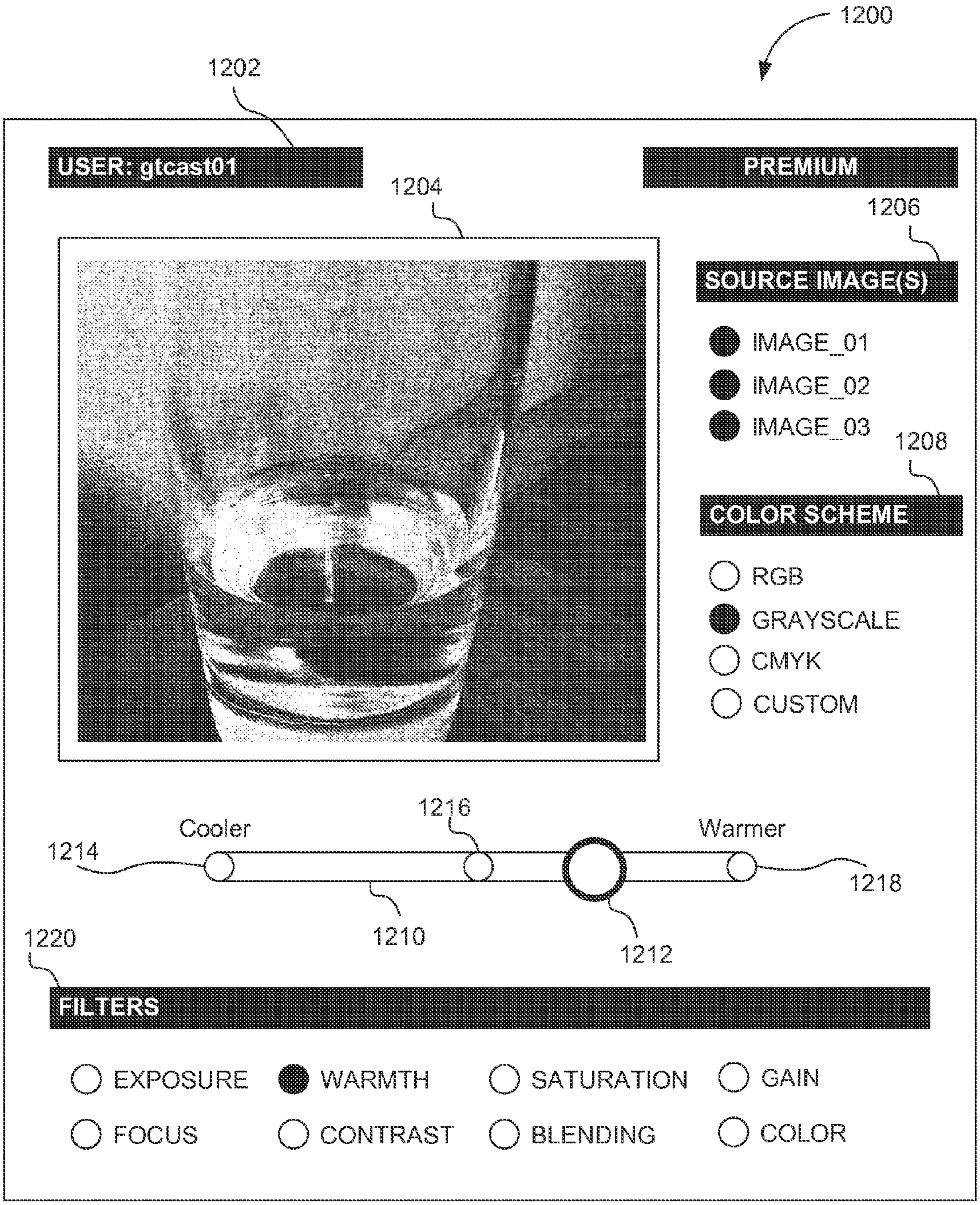

1200
1202
USER: gtcast01
PREMIUM
1204
1206
SOURCE IMAGE(S)
IMAGE_01
IMAGE_02
IMAGE_03
1208
COLOR SCHEME
RGB
GRAYSCALE
CMYK
CUSTOM
1216
Cooler
Warmer
1214
1218
1210
1212
1220
FILTERS
EXPOSURE
WARMTH
SATURATION
GAIN
FOCUS
CONTRAST
BLENDING
COLOR

Figure 12

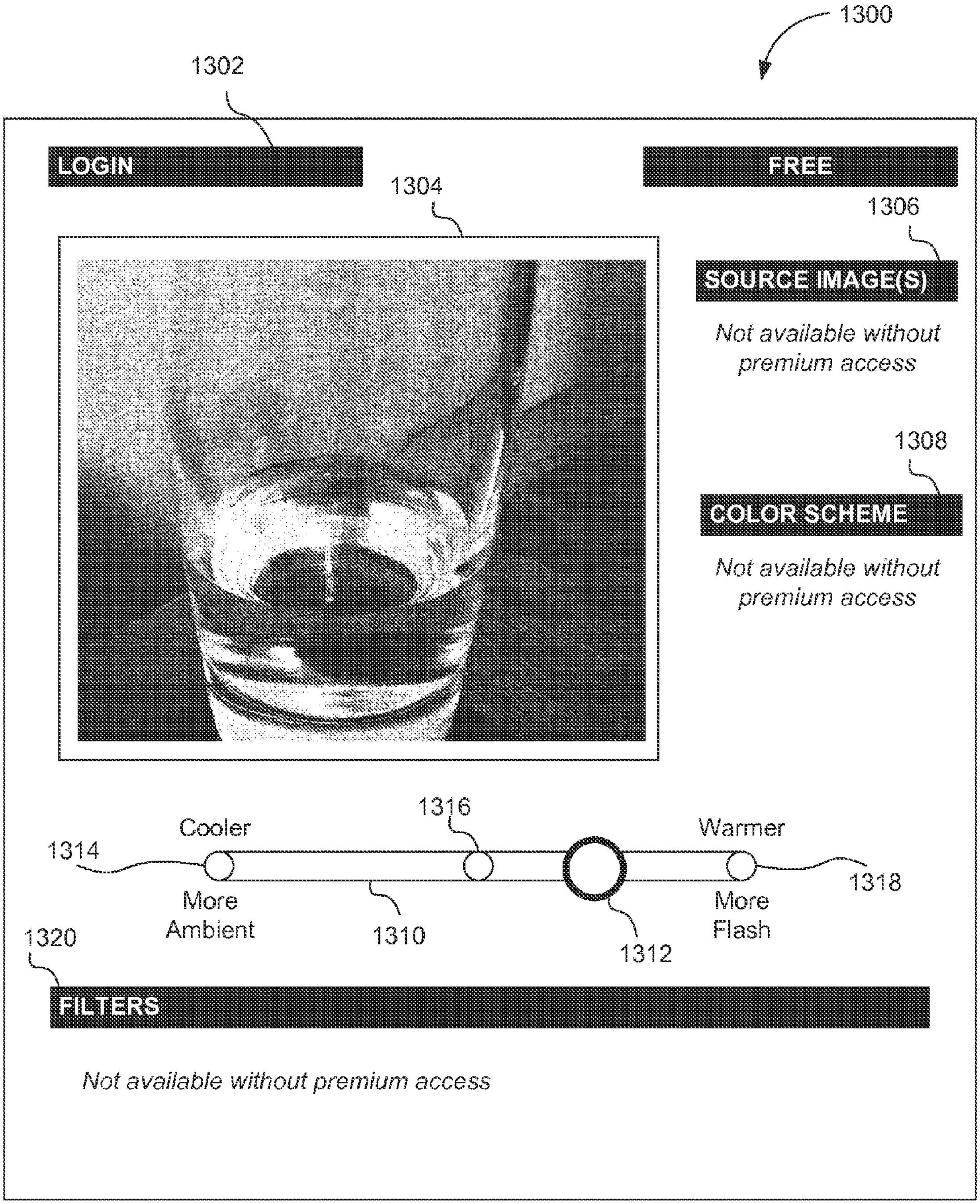

1300
1302
LOGIN
FREE
1304
1306
SOURCE IMAGE(S)
Not available without premium access
1308
COLOR SCHEME
Not available without premium access
1316
Cooler
Warmer
1314
1318
More Ambient
1310
1312
More Flash
1320
FILTERS
Not available without premium access

Figure 13

SYSTEM, METHOD, AND COMPUTER PROGRAM PRODUCT FOR EXCHANGING IMAGES

RELATED APPLICATIONS

The present application is a continuation-in-part of, and claims priority to U.S. patent application Ser. No. 14/535,285, entitled "SYSTEM, METHOD, AND COMPUTER PROGRAM PRODUCT FOR EXCHANGING IMAGES," filed Nov. 6, 2014. The foregoing application and/or patent is herein incorporated by reference in its entirety for all purposes.

Additionally, this application is a continuation-in-part of, and claims priority to U.S. patent application Ser. No. 14/517,731, entitled "SYSTEM, COMPUTER PROGRAM PRODUCT, AND METHOD FOR GENERATING A LIGHTWEIGHT SOURCE CODE FOR IMPLEMENTING AN IMAGE PROCESSING PIPELINE," filed Oct. 17, 2014. The foregoing application and/or patent is herein incorporated by reference in its entirety for all purposes.

Additionally, this application is a continuation-in-part of, and claims priority to U.S. patent application Ser. No. 14/503,210, entitled "SYSTEMS, METHODS, AND COMPUTER PROGRAM PRODUCTS FOR DIGITAL PHOTOGRAPHY," filed Sep. 30, 2014. The foregoing application and/or patent is herein incorporated by reference in its entirety for all purposes.

Additionally, this application is a continuation-in-part of and claims priority to U.S. patent application Ser. No. 14/503,224, entitled "SYSTEMS, METHODS, AND COMPUTER PROGRAM PRODUCTS FOR DIGITAL PHOTOGRAPHY," filed Sep. 30, 2014. The foregoing application and/or patent is herein incorporated by reference in its entirety for all purposes.

Additionally, this application is a continuation-in-part of, and claims priority to U.S. patent application Ser. No. 14/547,074, entitled "SYSTEM AND METHOD FOR GENERATING AN IMAGE RESULT BASED ON AVAILABILITY OF A NETWORK RESOURCE," filed Nov. 18, 2014. The foregoing application and/or patent is herein incorporated by reference in its entirety for all purposes.

FIELD OF THE INVENTION

The present invention relates to digital photographic systems, and more particularly to systems and methods for exchanging images.

BACKGROUND

Traditional digital photography systems are generally limited by the number of ways in which a user can exchange images. One solution to such limitation is to transfer images to a second device which can then share the images in some manner. Such a solution, however, can be cumbersome, time consuming, and require many steps of interactions before achieving the desired result. As such, there is thus a need for addressing these and/or other issues associated with the prior art.

SUMMARY

A system, method, and computer program product are provided for exchanging images. In use, one or more images are received at a server. Additionally, the one or more images are analyzed. Further, image processing code is outputted referencing the one or more images, based on the analysis of the one or more images. Additional systems, methods, and computer program products are also presented.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** illustrates an exemplary method for outputting image processing code, in accordance with one possible embodiment.

FIG. **2** illustrates an exemplary system carried out for outputting image processing code, in accordance with one embodiment.

FIG. **3**A illustrates a digital photographic system, in accordance with an embodiment.

FIG. **3**B illustrates a processor complex within the digital photographic system, according to one embodiment.

FIG. **3**C illustrates a digital camera, in accordance with an embodiment.

FIG. **3**D illustrates a wireless mobile device, in accordance with another embodiment.

FIG. **3**E illustrates a camera module configured to sample an image, according to one embodiment.

FIG. **3**F illustrates a camera module configured to sample an image, according to another embodiment.

FIG. **3**G illustrates a camera module in communication with an application processor, in accordance with an embodiment.

FIG. **4** illustrates a network service system, in accordance with another embodiment.

FIG. **5** illustrates a method for constructing a web application, in accordance with another embodiment.

FIG. **6** illustrates a method for exchanging images, in accordance with another embodiment.

FIG. **7** illustrates a method for exchanging images, in accordance with another embodiment.

FIG. **8** illustrates a method for determining whether a filter is to be included in a pipeline, in accordance with another embodiment.

FIG. **9** illustrates a user interface (UI) system for generating a combined image, according to one embodiment of the present invention

FIG. **10** is a method for generating a combined image, according to one embodiment of the present invention.

FIG. **11** illustrates a color adjustment graph for altering a color associated with an image, according to one embodiment of the present invention.

FIG. **12** illustrates a user interface (UI) for a first user, according to one embodiment of the present invention.

FIG. **13** illustrates a user interface (UI) for a second user, according to one embodiment of the present invention.

DETAILED DESCRIPTION

FIG. **1** illustrates an exemplary method **100** for outputting image processing code, in accordance with one embodiment. As an option, the method **100** may be carried out in the context of the details of any of the Figures disclosed herein. Of course, however, the method **100** may be carried out in any desired environment. Further, the aforementioned definitions may equally apply to the description below.

As shown, one or more images are received at a server. See operation **102**. Additionally, the one or more images are analyzed. See operation **104**. Lastly, image processing code referencing the one or more images is outputted, based on the analysis of the one or more images. See operation **106**.

In the context of the present description, image processing code includes code used to process one or more images in some manner. For example, in various embodiments, image processing code may include WebGL, OpenGL, code, OpenCL code, and/or any other code used to process graphics.

In one embodiment, the one or more images may be received at a server and analyzed upon receipt. In such an embodiment, the one or more images may be further outputted once the analyzing is complete. As such, in one embodiment, the flow of actions (e.g. images received, analysis of images, etc.) may be continuous until outputting occurs.

In another embodiment, the one or more images may be received and stored on a server, the analyzing and outputting occurring at a later time. In such an embodiment, the flow of actions (e.g. images received, analysis of images, etc.) may not be continuous from receipt of the images to the outputting. Of course, in other embodiments, the images may be stored for any length of time.

In one embodiment, the one or more images may include ancillary data associated with the one or more images. For example, in one embodiment, the one or more images may include metadata (e.g. camera type, film speed, ISO, aperture, etc.), and/or any other data (e.g. local URL to images and/or resources on the device which are being sent to the server, etc.) associated with the one or more images.

Still yet, in one embodiment, the analyzing may include at least one of creating at least one image, creating a high dynamic range (HDR) image, or processing at least one image. Of course, in other embodiments, the analyzing may include identifying metadata associated with an image, blending (or mixing) two or more images, applying an action based on metadata, and/or taking any other action associated with the image. Still yet, in some embodiments, analyzing the one or more images may include at least one of correcting white balance, correcting exposure levels, creating a high dynamic range (HDR) image, setting a black point, setting a white point, performing a dehaze function, performing a level mapping operation, performing a contrast enhancement operation, or adjusting a HDR strength. In a specific embodiment, a black point may be capable of being adjusted based on input by a user, in another embodiment, a white point may be capable of being adjusted based on input by a user.

In one embodiment, the image processing code may include or reference at least one image. For example, in such an embodiment, the image processing code may include one or more images, metadata (and/or other data) associated with the one or more images, local uniform resource locators (URLs) associated with the one or more images, instructions (e.g. for blending, for flattening, for creating a resulting image, etc.), and/or code for processing the one or more images in any manner. For example, in one embodiment, the image processing code may be sent back to a device from which the one or more images were received. In this embodiment, the image processing code may not send the original images back to the device, as they are already saved on the device, but may include code for processing (e.g. for blending, for flattening, for creating a resulting image, etc.) the one or more original images on the device. Of course, in such an embodiment, it is presumed that the resulting images can be created based on the one or more original images.

In another embodiment, the outputting may include at least one of providing access to a constructed web application associated with the one or more images, and/or pushing the web application associated with the one or more images to a recipient. In such an embodiment, the recipient may receive a URL (e.g. to a web application) and/or an address associated with the web application. The web application may include code to process the one or more images, and may permit the user, in real time, to manipulate the one or more images, including, but not limited to, blending two or more images, altering a parameter (e.g. exposure, ISO, warmth, color, saturation, contrast, etc.), identifying one or more points of interest (with potentially separate parameters, etc.), and/or applying any other modification to the one or more images.

In one embodiment, the outputting may include at least one of providing access to code created for rendering vector graphics in a web application, or providing access to a created resulting image which references one or more assets not stored on the server. For example, in one embodiment, one or more sections of code may be associated with a server, or may be associated entirely with the web application (e.g. functions and/or processing are not stored on a server, etc.). In another embodiment, the one or more assets not stored on the server may be stored on a client device such that a web application uses locally stored images in combination with the web application to create a resulting image. Further, in one embodiment, the outputting may include providing access to a created resulting image which references one or more assets not stored on the server. Additionally, in one embodiment, the one or more assets may be stored locally on a mobile device and/or any device (e.g. computer system, tablet, phone, etc.) which is separate from the server.

In an additional embodiment, the image processing code may reference one or more assets stored locally on the mobile device, as well as a resulting image stored on the server or, optionally, a different server. For example, in one embodiment, the web application may be accessed and utilized on a mobile device, and the image processing code may utilize one or more images on the mobile device as the basis for creating a resulting image. In one embodiment, the processing may occur via the image processing code which is sent from the server. Of course, in other embodiments, the resulting image may be stored in any location, including on the mobile device. In one embodiment, the resulting image may replace the one or more images originally used as the basis for creating the resulting image. In other embodiments, the resulting image may be added to the mobile device but not replace the one or more images. Still yet, in one embodiment, generating a resulting image may be based on one or more images, the resulting image being stored on the server.

In one embodiment, adjustable (e.g., sliding) indicia may be displayed utilizing a web application and one or more images may be blended based on a first aspect. Further, the one or more images may be blended based on a first aspect in response to the sliding indicia being manipulated by a user. In various embodiments, the first aspect may include at least one of a white balance, a focus, an exposure, a color correction, an intensity, and/or any other aspect associated with the one or more images.

In another embodiment, two or more versions of a web application associated with the one or more images may be constructed. For example, in one embodiment, at least one of the two or more versions may be associated with a paying account, a free account, a subscription service, a premium features account, and/or any other type of account. Of course, in one embodiment, a paying account (or any services based account) may be associated with a user identifier or a user account. In various embodiments, each version of the web application may provide a different set of features, at least in part, by which the one or more images are capable of being manipulated utilizing the web application.

FIG. **2** illustrates an exemplary system **200** carried out for outputting image processing code, in accordance with one embodiment. As an option, the system **200** may be implemented in the context of the details of any of the Figures disclosed herein. Of course, however, the system **200** may be implemented in any desired environment. Further, the aforementioned definitions may equally apply to the description below.

As shown, one or more images **206** may reside within a client **202**. In one embodiment, the client **202** may be connected to a server **204** via a data network **208**. For example, in one embodiment, the data network **208** may include an intranet, an internet, a local network (e.g. WLAN, WiFi, etc.), a cellular network, and/or any other type of network exchange.

As shown, one or more images **206** may reside within the server **204**. The one or more images (e.g. from the client, from the server, etc.) **206** may be evaluated **210**. In one embodiment, the evaluation **210** may cause an image **212** to be generated, and may cause a specification **214** to be created, the specification **214** being used to generate GL **216** (or any other processing code, etc.). Further, the generated image **212** and the generated GL **216** may comprise output **218**.

In one embodiment, the evaluation may include generating processing code (e.g. GL code, GL object, WebGL object, etc.). In another embodiment, the evaluation may include forming a stack of images associated with processing code. For example, in one embodiment, a stack of images may include a series of more than one images of differing exposure (e.g. EV−1, EV0, and EV+1, etc.) which may be blended to form a HDR image.

In another embodiment, the output **218** may include creating a package including the generated image **212** and the generated GL **216** (or any other processing code). In one embodiment, the output may include pushing the package to a client device. For example, the client device may include the client **202** which may have sent the one or more images **206** to the server **204**. In the context of the present description, a package may include, at a minimum, one or more generated images or references to images, and processing code for the one or more images.

In one embodiment, the one or more images may be pushed to a server for evaluation, or the one or more images may be already stored on a server for evaluation. Additionally, in one embodiment, the one or more images may be cached (e.g. stored, etc.) at a time before the evaluation occurs. Of course, in another embodiment, the caching may occur automatically. For example, in one embodiment, the user may have taken one or more photos on a mobile device, the one or more photos being saved to the mobile device and automatically uploaded to an online server (e.g. online cache, etc.), whereupon the online server may then evaluate the one or more photos.

Still yet, in one embodiment, the server may evaluate one image or more than one image. For example, an evaluation may include multiple frames of an image capture (e.g. with respect to a HDR, with respect to multiple ambient images and multiple flash images, etc.). In one embodiment, multiple images may be processed (e.g. individually and collectively, etc.) via a server, thereby displacing processing demands from a client device (e.g. mobile phone, tablet, etc.). In such an embodiment, the server can process higher quality (e.g. higher resolution, full frame, etc.) images. For example, the server may be configured to perform more computationally intensive operations, or operations that require data that may not stored on the mobile device to generate the higher quality images.

In one embodiment, the evaluation may include generating an image. As an example, the generating may include combining multiple images (e.g. creating an HDR, etc.). Additionally, the evaluation may include creating a specification and then generating GL (e.g. processing code, etc.) associated with the generated image. In one embodiment, the generated image may be manipulated based on the generated GL (and/or created specification, etc.).

In one embodiment, the specification may be created based on the evaluation performed by the server. For example, in one embodiment, the server may determine that the image is overexposed and may apply a filter to adjust the exposure, a filter to adjust the color tone, and a filter to adjust the contrast. Such filters may be inputted into the specification which is used as the basis for creating the processing code (e.g. GL code, etc.). In one embodiment, the output that is created (e.g. including the generated image and the generated GL, etc.) may allow the user to modify the one or more filters in some manner. Such modification may be associated with a weight value associated with the one or more filters previously defined in the specification and accounted for in the GL. In this manner, in such an embodiment, modifications made to the filter may be computed by the GL and a resulting image, based on the one or more images (e.g. generated image, etc.) provided by the server and commands as dictated by the GL, may be created.

In some embodiments, the output may be dependent on a type of client (user account type). For example, in one embodiment, the output may be designated for a premium services, free services, subscription service, and/or any other specific service associated with a client or individual. In another embodiment, the output may include more than one versions which may take into account the many types of users which may access the web app.

As an example, the output may include a premium service, the premium service allowing manipulation of or access to many filters including, but not limited to, exposure, focus; warmth, contrast, saturation, blending, gain, color, and/or any other parameter associated with the one or more images. In one embodiment, such filters may be controlled and/or manipulated through user input. In one embodiment, the user input may include a slider, an input box of weights (e.g. increase or decrease weight of filter, etc.), a gesture (e.g. thumbs up to increase, thumbs down to decrease, etc.), and/or any other feature which may be used to provide an input in some manner.

In one embodiment, a user may select a filter to modify an image, and a slider may allow the user to provide input on how to modify the particular filter with respect to the image. In another embodiment, manipulating a slider may affect one or more filters. For example, in one embodiment, increasing a warmth of a photograph may include increasing a blend of a flash image, increasing a gain for an image, increasing a temperature of an image, and/or otherwise changing a variety of filters to optimize the warmth of an image. Of course, any filter may be included and/or changed in response to manipulating a slider. In this manner, manipulating a slider may affect and/or change more than one filter associated with the one or more images.

In another embodiment, the premium service may include the ability to control which images (as provided by the server) are used to create the resulting image. Additionally, the user may be able to select a color scheme associated with the image, including, but not limited to, RGB, grayscale, CMYK, and/or any other color scale as defined by the user.

In a separate embodiment, the output may include a free service. In such an embodiment, the user may be able to control a slider, but not otherwise be permitted to control a selection of one or more filters, source of images, and/or color scheme. In some embodiments, manipulating the slider may alter one or more underlying filters, the output image being optimized based on the one or more altered filters. In one embodiment, having a slider associated with more than one filters may be configured to optimize the final output. For example, increasing the exposure alone may cause contrast and saturation to be lost in the image. As such, in one embodiment, saturation may likewise increase as exposure increases to compensate for lost color vibrancy. Of course, in other embodiments, any combination of filters may be used to optimize the resulting image.

As another example, in one embodiment, modifying a slider may adjust white balance, exposure, and color correction. In one embodiment, such modification may occur simultaneously. In one embodiment, a single slider may be used to control all three (or any number) of filters. In another embodiment, an option may be provided to separate the slider into three or a corresponding number) sliders, each one for the specific filter (e.g. a slider for white balance, exposure, and color correction, etc.). In this manner, the end user may choose to apply a bundle of filters via one slider, or may have the option to fine tune each of the filters which were applied.

In one embodiment, the output may include more than one version (e.g. premium, free, etc.) corresponding with specific processing code (e.g. GL code, etc.). In another embodiment, the output may be specific to one version (e.g. premium, free, etc.) corresponding with specific processing code (e.g. GL code, etc.). In this manner, the output corresponding to a specific one version will be more lightweight (e.g. less data required, etc.) than a package including more than one version.

In one embodiment, the one or more images may be included in a dynamic image object (DIO) package. Of course, any functionality associated with a DIO may be included, utilizing the systems and methods disclose within application Ser. No. 14/503,210, filed Sep. 30, 2014, entitled "SYSTEMS, METHODS, AND COMPUTER PROGRAM PRODUCTS FOR DIGITAL PHOTOGRAPHY"; and application Ser. No. 14/503,224, filed Sep. 30, 2014, entitled "SYSTEMS, METHODS, AND COMPUTER PROGRAM PRODUCTS FOR DIGITAL PHOTOGRAPHY", the contents of each are herein incorporated by reference.

In various embodiments, the output may be self-contained. For example, in one embodiment, the package associated with the output may contain ail of the processing code necessary to display and manipulate an image based on user feedback. In such an embodiment, the manipulation of an image does not require any interaction with a server (e.g. apart from providing the package, etc.), as all of the processing code may account for manipulation of the image.

Still yet, in one embodiment, applying a modification to the image (e.g. via a slider, etc.) may cause a modification to one or more elements that are used in processing code. For example, in one embodiment, modifying a slider may correspond with modifying a uniform which is used with GL code to generate a resulting image for display. In this manner, modifications to the image are requested directly to the processing code of the package without having to call a server.

In one embodiment, the one or more images may include at least some pre-evaluation application. For example, in one embodiment, a client device may use a preconfigured hardware element to correct a white balance and/or take any other action which may improve the one or more images. In this manner, the one or more images that are sent to the server (e.g. for storage, for evaluation, etc.) may reflect at least some pre-evaluation application. In other embodiments, it may be determined that evaluating (e.g. even by hardwired, etc.) may occur overall faster on a server, in which case, the client device may be used simply to capture and send without evaluating the one or more images. Of course, in other embodiments, any interaction between a client device and a server may be used to optimize the processing of the one or more images.

Additionally, in a further embodiment, the output may include a package of multiple images, the package referencing local URLs corresponding to the images, code for processing the one or more images, and/or any other relevant information (e.g. metadata, etc.) necessary to effectively modify the multiple images to create a final image. Further, the output may include a package referencing items both on a client device and in the package. For example, original images 1 and 2 may be stored on a client device, and image 3 may be the optimized generated image based on the original images 1 and 2. The output package may include image 3 (e.g. as created by the server, etc.) but not include images 1 and 2 if the output package is sent back to the user to manipulate the generated image. In such an embodiment, the user may manipulate the image, the manipulation referencing the original images 1 and 2 stored on the device, as well as image 3 which is included in the package (as provided by the server). In this manner, the output package may reference one or more images, which may be stored at more than one storage location.

More illustrative information will now be set forth regarding various optional architectures and uses in which the foregoing method may or may not be implemented, per the desires of the user. It should be strongly noted that the following information is set forth for illustrative purposes and should not be construed as limiting in any manner. Any of the following features may be optionally incorporated with or without the exclusion of other features described.

FIG. 3A illustrates a digital photographic system **300**, in accordance with one embodiment. As an option, the digital photographic system **300** may be implemented in the context of the details of any of the Figures disclosed herein. Of course, however, the digital photographic system **300** may be implemented in any desired environment. Further, the aforementioned definitions may equally apply to the description below.

As shown, the digital photographic system **300** may include a processor complex **310** coupled to a camera module **330** via an interconnect **334**. In one embodiment, the processor complex **310** is coupled to a strobe unit **336**. The digital photographic system **300** may also include, without limitation, a display unit **312**, a set of input/output devices **314**, non-volatile memory **316**, volatile memory **318**, a wireless unit **340**, and sensor devices **342**, each coupled to the processor complex **310**. In one embodiment, a power management subsystem **320** is configured to generate appropriate power supply voltages for each electrical load element within the digital photographic system **300**. A battery **322** may be configured to supply electrical energy to the power management subsystem **320**. The battery **322** may implement any technically feasible energy storage system, including primary or rechargeable battery technologies. Of course, in other embodiments, additional or fewer features, units, devices, sensors, or subsystems may be included in the system.

In one embodiment, a strobe unit **336** may be integrated into the digital photographic system **300** and configured to provide strobe illumination **350** during an image sample event performed by the digital photographic system **300**. In another embodiment, a strobe unit **336** may be implemented as an independent device from the digital photographic system **300** and configured to provide strobe illumination **350** during an image sample event performed by the digital photographic system **300**. The strobe unit **336** may comprise one or more LED devices, a gas-discharge illuminator (e.g. a Xenon strobe device, a Xenon flash lamp, etc.), or any other technically feasible illumination device. In certain embodiments, two or more strobe units are configured to synchronously generate strobe illumination in conjunction with sampling an image. In one embodiment, the strobe unit **336** is controlled through a strobe control signal **338** to either emit the strobe illumination **350** or not emit the strobe illumination **350**. The strobe control signal **338** may be implemented using any technically feasible signal transmission protocol. The strobe control signal **338** may indicate a strobe parameter (e.g. strobe intensity, strobe color, strobe time, etc.), for directing the strobe unit **336** to generate a specified intensity and/or color of the strobe illumination **350**. The strobe control signal **338** may be generated by the processor complex **310**, the camera module **330**, or by any other technically feasible combination thereof. In one embodiment, the strobe control signal **338** is generated by a camera interface unit within the processor complex **310** and transmitted to both the strobe unit **336** and the camera module **330** via the interconnect **334**. In another embodiment, the strobe control signal **338** is generated by the camera module **330** and transmitted to the strobe unit **336** via the interconnect **334**.

Optical scene information **352**, which may include at least a portion of the strobe illumination **350** reflected from objects in the photographic scene, is focused as an optical image onto an image sensor **332** within the camera module **330**. The image sensor **332** generates an electronic representation of the optical image. The electronic representation comprises spatial color intensity information, which may include different color intensity samples (e.g. red, green, and blue light, etc.). In other embodiments, the spatial color intensity information may also include samples for white light. The electronic representation is transmitted to the processor complex **310** via the interconnect **334**, which may implement any technically feasible signal transmission protocol.

In one embodiment, input/output devices **314** may include, without limitation, capacitive touch input surface, a resistive tablet input surface, one or more buttons, one or more knobs, light-emitting devices, light detecting devices, sound emitting devices, sound detecting devices, or any other technically feasible device for receiving user input and converting the input to electrical signals, or converting electrical signals into a physical signal. In one embodiment, the input/output devices **314** include a capacitive touch input surface coupled to a display unit **312**. A touch entry display system may include the display unit **312** and a capacitive touch input surface, also coupled to processor complex **310**.

Additionally, in other embodiments, non-volatile (NV) memory **316** is configured to store data when power is interrupted. In one embodiment, the NV memory **316** comprises one or more flash memory devices (e.g. ROM, PCM, FeRAM, FRAM, PRAM, MRAM, NRAM, etc.). The NV memory **316** comprises a non-transitory computer-readable medium, which may be configured to include programming instructions for execution by one or more processing units within the processor complex **310**. The programming instructions may implement, without limitation, an operating system (OS), UI software modules, image processing and storage software modules, one or more input/output devices **314** connected to the processor complex **310**, one or more software modules for sampling an image stack through camera module **330**, one or more software modules for presenting the image stack or one or more synthetic images generated from the image stack through the display unit **312**. As an example, in one embodiment, the programming instructions may also implement one or more software modules for merging images or portions of images within the image stack, aligning at least portions of each image within the image stack, or a combination thereof. In another embodiment, the processor complex **310** may be configured to execute the programming instructions, which may implement one or more software modules operable to create a high dynamic range (HDR) image.

Still yet, in one embodiment, one or more memory devices comprising the NV memory **316** may be packaged as a module configured to be installed or removed by a user. In one embodiment, volatile memory **318** comprises dynamic random access memory (DRAM) configured to temporarily store programming instructions, image data such as data associated with an image stack, and the like, accessed during the course of normal operation of the digital photographic system **300**. Of course, the volatile memory may be used in any manner and in association with any other input/output device **314** or sensor device **342** attached to the process complex **310**.

In one embodiment, sensor devices **342** may include, without limitation, one or more of an accelerometer to detect motion and/or orientation, an electronic gyroscope to detect motion and/or orientation, a magnetic flux detector to detect orientation, a global positioning system (GPS) module to detect geographic position, or any combination thereof. Of course, other sensors, including but not limited to a motion detection sensor, a proximity sensor, an RGB light sensor, a gesture sensor, a 3-D input image sensor, a pressure sensor, and an indoor position sensor, may be integrated as sensor devices. In one embodiment, the sensor devices may be one example of input/output devices **314**.

Wireless unit **340** may include one or more digital radios configured to send and receive digital data. In particular, the wireless unit **340** may implement wireless standards (e.g. WiFi, Bluetooth, NFC, etc.), and may implement digital cellular telephony standards for data communication (e.g. CDMA, 3G, 4G, LTE, LTE-Advanced, etc.). Of course, any wireless standard or digital cellular telephony standards may be used.

In one embodiment, the digital photographic system **300** is configured to transmit one or more digital photographs to a network-based (online) or "cloud-based" photographic media service via the wireless unit **340**. The one or more digital photographs may reside within either the NV memory **316** or the volatile memory **318**, or any other memory device associated with the processor complex **310**. In one embodiment, a user may possess credentials to access an online photographic media service and to transmit one or more digital photographs for storage to, retrieval from, and presentation by the online photographic media service. The credentials may be stored or generated within the digital photographic system **300** prior to transmission of the digital photographs. The online photographic media service may comprise a social networking service, photograph sharing service, or any other network-based service that provides storage of digital photographs, processing of digital photographs, transmission of digital photographs, sharing of digital photographs, or any combination thereof. In certain embodiments, one or more digital photographs are generated by the online photographic media service based on image data (e.g. image stack, HDR image stack, image package, etc.) transmitted to servers associated with the online photographic media service. In such embodiments, a user may upload one or more source images from the digital photographic system **300** for processing by the online photographic media service.

In one embodiment, the digital photographic system **300** comprises at least one instance of a camera module **330**. In another embodiment, the digital photographic system **300** comprises a plurality of camera modules **330**. Such an embodiment may also include at least one strobe unit **336** configured to illuminate a photographic scene, sampled as multiple views by the plurality of camera modules **330**. The plurality of camera modules **330** may be configured to sample a wide angle view (e.g., greater than forty-five degrees of sweep among cameras) to generate a panoramic photograph. In one embodiment, a plurality of camera modules **330** may be configured to sample two or more narrow angle views (e.g., less than forty-five degrees of sweep among cameras) to generate a stereoscopic photograph. In other embodiments, a plurality of camera modules **330** may be configured to generate a 3-D image or to otherwise display a depth perspective (e.g. a z-component, etc.) as shown on the display unit **312** or any other display device.

In one embodiment, a display unit **312** may be configured to display a two-dimensional array of pixels to form an image for display. The display unit **312** may comprise a liquid-crystal (LCD) display, a light-emitting diode (LED) display, an organic LED display, or any other technically feasible type of display. In certain embodiments, the display unit **312** may be able to display a narrower dynamic range of image intensity values than a complete range of intensity values sampled from a photographic scene, such as within a single HDR image or over a set of two or more images comprising a multiple exposure or HDR image stack. In one embodiment, images comprising an image stack may be merged according to any technically feasible HDR blending technique to generate a synthetic image for display within dynamic range constraints of the display unit **312**. In one embodiment, the limited dynamic range may specify an eight-bit per color channel binary representation of corresponding color intensities. In other embodiments, the limited dynamic range may specify more than eight-bits (e.g., 10 bits, 12 bits, or 14 bits, etc.) per color channel binary representation.

FIG. **3**B illustrates a processor complex **310** within the digital photographic system **300** of FIG. **3**A, in accordance with one embodiment. As an option, the processor complex **310** may be implemented in the context of the details of any of the Figures disclosed herein. Of course, however, the processor complex **310** may be implemented in any desired environment. Further, the aforementioned definitions may equally apply to the description below.

As shown, the processor complex **310** includes a processor subsystem **360** and may include a memory subsystem **362**. In one embodiment, processor complex **310** may comprise a system on a chip (SoC) device that implements processor subsystem **360**, and memory subsystem **362** comprises one or more DRAM devices coupled to the processor subsystem **360**. In another embodiment, the processor complex **310** may comprise a multi-chip module (MCM) encapsulating the SoC device and the one or more DRAM devices comprising the memory subsystem **362**.

The processor subsystem **360** may include, without limitation, one or more central processing unit (CPU) cores **370**, a memory interface **380**, input/output interfaces unit **384**, and a display interface unit **382**, each coupled to an interconnect **374**. The one or more CPU cores **370** may be configured to execute instructions residing within the memory subsystem **362**, volatile memory **318**, NV memory **316**, or any combination thereof. Each of the one or more CPU cores **370** may be configured to retrieve and store data through interconnect **374** and the memory interface **380**. In one embodiment, each of the one or more CPU cores **370** may include a data cache, and an instruction cache. Additionally, two or more of the CPU cores **370** may share a data cache, an instruction cache, or any combination thereof. In one embodiment, a cache hierarchy is implemented to provide each CPU core **370** with a private cache layer, and a shared cache layer.

In some embodiments, processor subsystem **360** may include one or more graphics processing unit (GPU) cores **372**. Each GPU core **372** may comprise a plurality of multi-threaded execution units that may be programmed to implement, without limitation, graphics acceleration functions. In various embodiments, the GPU cores **372** may be configured to execute multiple thread programs according to well-known standards (e.g. OpenGL™, WebGL™, OpenCL™, CUDA™, etc.), and/or any other programmable rendering graphic standard. In certain embodiments, at least one GPU core **372** implements at least a portion of a motion estimation function, such as a well-known Harris detector or a well-known Hessian-Laplace detector. Such a motion estimation function may be used at least in part to align images or portions of images within an image stack. For example, in one embodiment, an HDR image may be compiled based on an image stack, where two or more images are first aligned prior to compiling the HDR image.

As shown, the interconnect **374** is configured to transmit data between and among the memory interface **380**, the display interface unit **382**, the input/output interfaces unit **384**, the CPU cores **370**, and the GPU cores **372**. In various embodiments, the interconnect **374** may implement one or more buses, one or more rings, a cross-bar, a mesh, or any other technically feasible data transmission structure or technique. The memory interface **380** is configured to couple the memory subsystem **362** to the interconnect **374**. The memory interface **380** may also couple NV memory **316**, volatile memory **318**, or any combination thereof to the interconnect **374**. The display interface unit **382** may be configured to couple a display unit **312** to the interconnect **374**. The display interface unit **382** may implement certain frame buffer functions (e.g. frame refresh, etc). Alternatively, in another embodiment, the display unit **312** may implement certain frame buffer functions (e.g. frame refresh, etc.). The input/output interfaces unit **384** may be configured to couple various input/output devices to the interconnect **374**.

In certain embodiments, a camera module **330** is configured to store exposure parameters for sampling each image associated with an image stack. For example, in one embodiment, when directed to sample a photographic scene, the camera module **330** may sample a set of images comprising the image stack according to stored exposure parameters. A software module comprising programming instructions executing within a processor complex **310** may generate and store the exposure parameters prior to directing the camera module **330** to sample the image stack. In other embodiments, the camera module **330** may be used to meter an image or an image stack, and the software module comprising programming instructions executing within a processor complex **310** may generate and store metering parameters prior to directing the camera module **330** to capture the image. Of course, the camera module **330** may be used in any manner in combination with the processor complex **310**.

In one embodiment, exposure parameters associated with images comprising the image stack may be stored within an exposure parameter data structure that includes exposure parameters for one or more images. In another embodiment, a camera interface unit (not shown in FIG. **3**B) within the processor complex **310** may be configured to read exposure parameters from the exposure parameter data structure and to transmit associated exposure parameters to the camera module **330** in preparation of sampling a photographic scene. After the camera module **330** is configured according to the exposure parameters, the camera interface may direct the camera module **330** to sample the photographic scene; the camera module **330** may then generate a corresponding image stack. The exposure parameter data structure may be stored within the camera interface unit, a memory circuit within the processor complex **310**, volatile memory **318**, NV memory **316**, the camera module **330**, or within any other technically feasible memory circuit. Further, in another embodiment, a software module executing within processor complex **310** may generate and store the exposure parameter data structure.

FIG. **3**C illustrates a digital camera **302**, in accordance with one embodiment. As an option, the digital camera **302** may be implemented in the context of the details of any of the Figures disclosed herein. Of course, however, the digital camera **302** may be implemented in any desired environment. Further, the aforementioned definitions may equally apply to the description below.

In one embodiment, the digital camera **302** may be configured to include a digital photographic system, such as digital photographic system **300** of FIG. **3**A. As shown, the digital camera **302** includes a camera module **330**, which may include optical elements configured to focus optical scene information representing a photographic scene onto an image sensor, which may be configured to convert the optical scene information to an electronic representation of the photographic scene.

Additionally, the digital camera **302** may include a strobe unit **336**, and may include a shutter release button **315** for triggering a photographic sample event, whereby digital camera **302** samples one or more images comprising the electronic representation. In other embodiments, any other technically feasible shutter release mechanism may trigger the photographic sample event (e.g. such as a timer trigger or remote control trigger, etc.).

FIG. **3**D illustrates a wireless mobile device **376**, in accordance with one embodiment. As an option, the mobile device **376** may be implemented in the context of the details of any of the Figures disclosed herein. Of course, however, the mobile device **376** may be implemented in any desired environment. Further, the aforementioned definitions may equally apply to the description below.

In one embodiment, the mobile device **376** may be configured to include a digital photographic system (e.g. such as digital photographic system **300** of FIG. **3**A), which is configured to sample a photographic scene. In various embodiments, a camera module **330** may include optical elements configured to focus optical scene information representing the photographic scene onto an image sensor, which may be configured to convert the optical scene information to an electronic representation of the photographic scene. Further, a shutter release command may be generated through any technically feasible mechanism, such as a virtual button, which may be activated by a touch gesture on a touch entry display system comprising display unit **312**, or a physical button, which may be located on any face or surface of the mobile device **376**. Of course, in other embodiments, any number of other buttons, external inputs/outputs, or digital inputs/outputs may be included on the mobile device **376**, and which may be used in conjunction with the camera module **330**.

As shown, in one embodiment, a touch entry display system comprising display unit **312** is disposed on the opposite side of mobile device **376** from camera module **330**. In certain embodiments, the mobile device **376** includes a user-facing camera module **331** and may include a user-facing strobe unit (not shown). Of course, in other embodiments, the mobile device **376** may include any number of user-facing camera modules or rear-facing camera modules, as well as any number of user-facing strobe units or rear-facing strobe units.

In some embodiments, the digital camera **302** and the mobile device **376** may each generate and store a synthetic image based on an image stack sampled by camera module **330**. The image stack may include one or more images sampled under ambient lighting conditions, one or more images sampled under strobe illumination from strobe unit **336**, or a combination thereof.

FIG. **3**E illustrates camera module **330**, in accordance with one embodiment. As an option, the camera module **330** may be implemented in the context of the details of any of the Figures disclosed herein. Of course, however, the camera module **330** may be implemented in any desired environment. Further, the aforementioned definitions may equally apply to the description below.

In one embodiment, the camera module **330** may be configured to control strobe unit **336** through strobe control signal **338**. As shown, a lens **390** is configured to focus optical scene information **352** onto image sensor **332** to be sampled. In one embodiment, image sensor **332** advantageously controls detailed timing of the strobe unit **336** though the strobe control signal **338** to reduce inter-sample time between an image sampled with the strobe unit **336** enabled, and an image sampled with the strobe unit **336** disabled. For example, the image sensor **332** may enable the strobe unit **336** to emit strobe illumination **350** less than one microsecond (or any desired length) after image sensor **332** completes an exposure time associated with sampling an ambient image and prior to sampling a strobe image.

In other embodiments, the strobe illumination **350** may be configured based on a desired one or more target points. For example, in one embodiment, the strobe illumination **350** may light up an object in the foreground, and depending on the length of exposure time, may also light up an object in the background of the image. In one embodiment, once the strobe unit **336** is enabled, the image sensor **332** may then immediately begin exposing a strobe image. The image sensor **332** may thus be able to directly control sampling operations, including enabling and disabling the strobe unit **336** associated with generating an image stack, which may comprise at least one image sampled with the strobe unit **336** disabled, and at least one image sampled with the strobe unit **336** either enabled or disabled. In one embodiment, data comprising the image stack sampled by the image sensor **332** is transmitted via interconnect **334** to a camera interface unit **386** within processor complex **310**. In some embodiments, the camera module **330** may include an image sensor controller, which may be configured to generate the strobe control signal **338** in conjunction with controlling operation of the image sensor **332**.

FIG. **3**F illustrates a camera module **330**, in accordance with one embodiment. As an option, the camera module **330** may be implemented in the context of the details of any of the Figures disclosed herein. Of course, however, the camera module **330** may be implemented in any desired environment. Further, the aforementioned definitions may equally apply to the description below.

In one embodiment, the camera module **330** may be configured to sample an image based on state information for strobe unit **336**. The state information may include, without limitation, one or more strobe parameters (e.g. strobe intensity, strobe color, strobe time, etc.), for directing the strobe unit **336** to generate a specified intensity and/or color of the strobe illumination **350**. In one embodiment, commands for configuring the state information associated with the strobe unit **336** may be transmitted through a strobe control signal **338**, which may be monitored by the camera module **330** to detect when the strobe unit **336** is enabled. For example, in one embodiment, the camera module **330** may detect when the strobe unit **336** is enabled or disabled within a microsecond or less of the strobe unit **336** being enabled or disabled by the strobe control signal **338**. To sample an image requiring strobe illumination, a camera interface unit **386** may enable the strobe unit **336** by sending an enable command through the strobe control signal **338**. In one embodiment, the camera interface unit **386** may be included as an interface of input/output interfaces **384** in a processor subsystem **360** of the processor complex **310** of FIG. **3**B The enable command may comprise a signal level transition, a data packet, a register write, or any other technically feasible transmission of a command. The camera module **330** may sense that the strobe unit **336** is enabled and then cause image sensor **332** to sample one or more images requiring strobe illumination while the strobe unit **336** is enabled. In such an implementation, the image sensor **332** may be configured to wait for an enable signal destined for the strobe unit **336** as a trigger signal to begin sampling a new exposure.

In one embodiment, camera interface unit **386** may transmit exposure parameters and commands to camera module **330** through interconnect **334**. In certain embodiments, the camera interface unit **386** may be configured to directly control strobe unit **336** by transmitting control commands to the strobe unit **336** through strobe control signal **338**. By directly controlling both the camera module **330** and the strobe unit **336**, the camera interface unit **386** may cause the camera module **330** and the strobe unit **336** to perform their respective operations in precise time synchronization. In one embodiment, precise time synchronization may be less than five hundred microseconds of event timing error. Additionally, event timing error may be a difference in time from an intended event occurrence to the time of a corresponding actual event occurrence.

In another embodiment, camera interface unit **386** may be configured to accumulate statistics while receiving image data from camera module **330**. In particular, the camera interface unit **386** may accumulate exposure statistics for a given image while receiving image data for the image through interconnect **334**. Exposure statistics may include, without limitation, one or more of an intensity histogram, a count of over-exposed pixels, a count of under-exposed pixels, an intensity-weighted sum of pixel intensity, or any combination thereof. The camera interface unit **386** may present the exposure statistics as memory-mapped storage locations within a physical or virtual address space defined by a processor, such as one or more of CPU cores **370**, within processor complex **310**. In one embodiment, exposure statistics reside in storage circuits that are mapped into a memory-mapped register space, which may be accessed through the interconnect **334**. In other embodiments, the exposure statistics are transmitted in conjunction with transmitting pixel data for a captured image. For example, the exposure statistics for a given image may be transmitted as in-line data, following transmission of pixel intensity data for the captured image. Exposure statistics may be calculated, stored, or cached within the camera interface unit **386**.

In one embodiment, camera interface unit **386** may accumulate color statistics for estimating scene white-balance. Any technically feasible color statistics may be accumulated for estimating white balance, such as a sum of intensities for different color channels comprising red, green, and blue color channels. The sum of color channel intensities may then be used to perform a white-balance color correction on an associated image, according to a white-balance model such as a gray-world white-balance model. In other embodiments, curve-fitting statistics are accumulated for a linear or a quadratic curve fit used for implementing white-balance correction on an image.

In one embodiment, camera interface unit **386** may accumulate spatial color statistics for performing color-matching between or among images, such as between or among an ambient image and one or more images sampled with strobe illumination. As with the exposure statistics, the color statistics may be presented as memory-mapped storage locations within processor complex **310**. In one embodiment, the color statistics are mapped in a memory-mapped register space, which may be accessed through interconnect **334**, within processor subsystem **360**. In other embodiments, the color statistics may be transmitted in conjunction with transmitting pixel data for a captured image. For example, in one embodiment, the color statistics for a given image may be transmitted as in-line data, following transmission of pixel intensity data for the image. Color statistics may be calculated, stored, or cached within the camera interface **386**.

In one embodiment, camera module **330** may transmit strobe control signal **338** to strobe unit **336**, enabling the strobe unit **336** to generate illumination while the camera module **330** is sampling an image. In another embodiment, camera module **330** may sample an image illuminated by strobe unit **336** upon receiving an indication signal from camera interface unit **386** that the strobe unit **336** is enabled. In yet another embodiment, camera module **330** may sample an image illuminated by strobe unit **336** upon detecting strobe illumination within a photographic scene via a rapid rise in scene illumination. In one embodiment, a rapid rise in scene illumination may include at least a rate of increasing intensity consistent with that of enabling strobe unit **336**. In still yet another embodiment, camera module **330** may enable strobe unit **336** to generate strobe illumination while sampling one image, and disable the strobe unit **336** while sampling a different image.

FIG. **3**G illustrates camera module **330**, in accordance with one embodiment. As an option, the camera module **330** may be implemented in the context of the details of any of the Figures disclosed herein. Of course, however, the camera module **330** may be implemented in any desired environment. Further, the aforementioned definitions may equally apply to the description below.

In one embodiment, the camera module **330** may be in communication with an application processor **335**. The camera module **330** is shown to include image sensor **332** in communication with a controller **333**. Further, the controller **333** is shown to be in communication with the application processor **335**.

In one embodiment, the application processor **335** may reside outside of the camera module **330**. As shown, the lens **390** may be configured to focus optical scene information onto image sensor **332** to be sampled. The optical scene information sampled by the image sensor **332** may then be communicated from the image sensor **332** to the controller **333** for at least one of subsequent processing and communication to the application processor **335**. In another embodiment, the controller **333** may control storage of the optical scene information sampled by the image sensor **332**, or storage of processed optical scene information.

In another embodiment, the controller **333** may enable a strobe unit to emit strobe illumination for a short time duration (e.g. less than one microsecond, etc.) after image sensor **332** completes an exposure time associated with sampling an ambient image. Further, the controller **333** may be configured to generate strobe control signal **338** in conjunction with controlling operation of the image sensor **332**.

In one embodiment, the image sensor **332** may be a complementary metal oxide semiconductor (CMOS) sensor or a charge-coupled device (CCD) sensor. In another embodiment, the controller **333** and the image sensor **332** may be packaged together as an integrated system or integrated circuit. In yet another embodiment, the controller **333** and the image sensor **332** may comprise discrete packages. In one embodiment, the controller **333** may provide circuitry for receiving optical scene information from the image sensor **332**, processing of the optical scene information, timing of various functionalities, and signaling associated with the application processor **335**. Further, in another embodiment, the controller **333** may provide circuitry for control of one or more of exposure, shuttering, white balance, and gain adjustment. Processing of the optical scene information by the circuitry of the controller **333** may include one or more of gain application, amplification, and analog-to-digital conversion. After processing the optical scene information, the controller **333** may transmit corresponding digital pixel data, such as to the application processor **335**.

In one embodiment, the application processor **335** may be implemented on processor complex **310** and at least one of volatile memory **318** and NV memory **316**, or any other memory device and/or system. The application processor **335** may be previously configured for processing of received optical scene information or digital pixel data communicated from the camera module **330** to the application processor **335**.

FIG. **4** illustrates a network service system **400**, in accordance with one embodiment. As an option, the network service system **400** may be implemented in the context of the details of any of the Figures disclosed herein. Of course, however, the network service system **400** may be implemented in any desired environment. Further, the aforementioned definitions may equally apply to the description below.

In one embodiment, the network service system **400** may be configured to provide network access to a device implementing a digital photographic system. As shown, network service system **400** includes a wireless mobile device **376**, a wireless access point **472**, a data network **474**, data center **480**, and a data center **481**. The wireless mobile device **376** may communicate with the wireless access point **472** via a digital radio link **471** to send and receive digital data, including data associated with digital images. The wireless mobile device **376** and the wireless access point **472** may implement any technically feasible transmission techniques for transmitting digital data via digital a radio link **471** without departing the scope and spirit of the present invention. In certain embodiments, one or more of data centers **480**, **481** may be implemented using virtual constructs so that each system and subsystem within a given data center **480**, **481** may comprise virtual machines configured to perform specified data processing and network tasks. In other implementations, one or more of data centers **480**, **481** may be physically distributed over a plurality of physical sites.

The wireless mobile device **376** may comprise a smart phone configured to include a digital camera, a digital camera configured to include wireless network connectivity, a reality augmentation device, a laptop configured to include a digital camera and wireless network connectivity, or any other technically feasible computing device configured to include a digital photographic system and wireless network connectivity.

In various embodiments, the wireless access point **472** may be configured to communicate with wireless mobile device **376** via the digital radio link **471** and to communicate with the data network. **474** via any technically feasible transmission media, such as any electrical, optical, or radio transmission media. For example, in one embodiment, wireless access point **472** may communicate with data network **474** through an optical fiber coupled to the wireless access point **472** and to a router system or a switch system within the data network **474**. A network link **475**, such as a wide area network (WAN) link, may be configured to transmit data between the data network **474** and the data center **480**.

In one embodiment, the data network **474** may include routers, switches, long-haul transmission systems, provisioning systems, authorization systems, and any technically feasible combination of communications and operations subsystems configured to convey data between network endpoints, such as between the wireless access point **472** and the data center **480**. In one implementation, a wireless the mobile device **376** may comprise one of a plurality of wireless mobile devices configured to communicate with the data center **480** via one or more wireless access points coupled to the data network **474**.

Additionally, in various embodiments, the data center **480** may include, without limitation, a switch/router **482** and at least one data service system **484**. The switch/router **482** may be configured to forward data traffic between and among a network link **475**, and each data service system **484**. The switch/router **482** may implement any technically feasible transmission techniques, such as Ethernet media layer transmission, layer **2** switching, layer **3** routing, and the like. The switch/router **482** may comprise one or more individual systems configured to transmit data between the data service systems **484** and the data network **474**.

In one embodiment, the switch/router **482** may implement session-level load balancing among a plurality of data service systems **484**. Each data service system **484** may include at least one computation system **488** and may also include one or more storage systems **486**. Each computation system **488** may comprise one or more processing units, such as a central processing unit, a graphics processing unit, or any combination thereof. A given data service system **484** may be implemented as a physical system comprising one or more physically distinct systems configured to operate together. Alternatively, a given data service system **484** may be implemented as a virtual system comprising one or more virtual systems executing on an arbitrary physical system. In certain scenarios, the data network **474** may be configured to transmit data between the data center **480** and another data center **481**, such as through a network link **476**.

In another embodiment, the network service system **400** may include any networked mobile devices configured to implement one or more embodiments of the present invention. For example, in some embodiments, a peer-to-peer network, such as an ad-hoc wireless network, may be established between two different wireless mobile devices. In such embodiments, digital image data may be transmitted between the two wireless mobile devices without having to send the digital image data to a data center **480**.

FIG. **5** illustrates a method **500** for constructing a web application, in accordance with another embodiment. As an option, the method **500** may be implemented in the context of the details of any of the Figures disclosed herein. Of course, however, the method **500** may be implemented in any desired environment. Further, the aforementioned definitions may equally apply to the description below.

As shown, the method begins with receiving an image. See operation **502**. As described hereinabove, the image may include one or more images, which may be received by a server. After being received, the one or more images may be evaluated. See operation **504**.

In one embodiment, the evaluation may include generating processing code (e.g. GL code, GL object, WebGL object, etc.). In another embodiment, the evaluation may include forming a stack of images associated with processing code. For example, in one embodiment, a stack of images may include a series of EV−1, EV0, and EV+1 images which may be blended to form a HDR image. Additionally, the evaluation may include generating an image. As an example, the generating may include combining multiple images (e.g. creating an HDR, etc.). Additionally, the evaluation may include creating a specification and then generating processing code associated with the generated image. In one embodiment, the generated image may be manipulated based on the processing code (and/or created specification, etc.).

As shown, it is determined if the evaluation is complete. See decision **506**. In one embodiment, an evaluation may proceed in steps, including for example, correcting a white balance, correcting a saturation, creating processing code, creating a blended image, and/or taking any series of actions. In a separate embodiment, an evaluation may proceed in a parallel fashion whereby each of the filters (e.g. white balance, saturation, etc.) and/or processing (e.g. create GL code, create blended image, etc.) may occur near simultaneously.

After completing the evaluation, an image may be generated. See operation **508**. In one embodiment, the image may be generated at the conclusion of an evaluation step (e.g. after filters have been identified and applied, etc.). In another embodiment, the image may be generated as part of the evaluation step.

After an image is generated, a web application is constructed. See operation **510**. In one embodiment, the web application may be created based on an output including a package, the package including a generated image, processing code (e.g. GL code, etc.), and/or any other data necessary to independently control and modify the generated image. In one embodiment, the package may include a web application.

In one embodiment, multiple versions or a specific version based on a user account type of a web application may be created prior to outputting a package. For example, in one embodiment, a premium (paid) version and/or a free version web application may be created, but the output package may include one and/or both of the versions, depending on the intended recipient.

For example, as shown, after constructing a web application, it is determined whether there is a paying account. See decision **512**. In one embodiment, if it is a paying account, a full functionality application may be provided. See operation **514**. In another embodiment, if an account is not a paying account, then a limited functionality application may be provided. See operation **516**. Further, it is determined whether feedback is received. See decision **518**.

In one embodiment, a first feedback may be associated with a full functionality application and a second feedback may be associated with a limited functionality application. For example, in one embodiment, the first feedback may include one or more modifications made to one or more features. In another embodiment, the second feedback may include one or more modifications made to a single feature.

For example, in various embodiments, the first feedback may be comprised of multiple settings, including a modification made to a filter (e.g. white balance, saturation, etc.), to processing (e.g. GL code, blending of two or more images, etc.), to the selected images (e.g. used as the basis for blending, etc.), and/or any other modification. In one embodiment, the first feedback may include a first modification and a second modification, the first modification and second modification being received simultaneous and/or at a separate time. For example, in one embodiment, a first modification may be received at a first time and a second modification may be received at a second time, wherein the first time and the second time are different times. Additionally, the first modification may include a set of modifications and the second modification may include a set of modifications.

As shown, if feedback is received, then the modification(s) are displayed on the full functionality application or the limited functionality application, depending on whether the web application is associated with a paying account. In one embodiment, the web application may include processing code necessary to implement the changes received via the feedback. In another embodiment, the feedback may be sent to a server to generate an image, and reconstruct a web application. In such an embodiment, it may be necessary to send such feedback to a server in the event that, for example, a custom setting or a new filter is created by the user. In other embodiments, however, if a new filter or custom filter is not created, then the processing code contained in the web application may contain all of the code necessary to implement the one or more modifications inputted by the user.

FIG. **6** illustrates a method **600** for exchanging images, in accordance with another embodiment. As an option, the method **600** may be implemented in the context of the details of any of the Figures disclosed herein. Of course, however, the method **600** may be implemented in any desired environment. Further, the aforementioned definitions may equally apply to the description below.

As shown, one or more images are selected. See operation **602**. Additionally, a package of the one or more images and metadata is created. See operation **604**. Local URLs for the client device are identified. See operation **606**. Further, the package is sent from the client device to the server. See operation **608**.

In one embodiment, the selection of the one or more images may occur manually. For example, in one embodiment, after capturing a number of images, a user may select all or a subset of the captured images. In another embodiment, the selection of the one or more images may occur automatically. For example, in one embodiment, after capturing a single image, the image may be automatically packaged and sent to a server for processing. In another embodiment, the package may be sent once a threshold is reached (e.g. a minimum of five photos, a set number of photos within a specified time frame, etc).

In various embodiments, local URLs may be identified once the package is created. For example, before sending the package to a server, the device may analyze the contents of the package and provide a local URL for any resource e.g. photo, metadata, data, etc.) being transferred. In a separate embodiment, local URLs may be already associated with the one or more images and/or metadata. For example, in one embodiment, when one or more images are selected, the selection may inherently include an address to the one or more images (e.g. sdcard/DCIM/images/image001.jpg, etc.). In such an embodiment, the address associated with the location of the image to be uploaded may be used as an identification (included in the package) of a local URL. For example, when a hypothetical image 01 is selected on client device X, the address of the location where the image is stored is first determined. Such a location may be included in the package which is subsequently sent to a server for processing. The server may identify which assets are stored locally on client device X.

As shown, the one or more images are processed at the server. See operation **610**. In one embodiment, the processing at the server may be analogous to evaluating image in operation **504**. The processing may analyze the one or more images, the associated metadata, and/or any other data which is contained in the sent package. In one embodiment, the processing may include enhancing the image in some manner (e.g. correct white balance, fix contrast, etc.). In other embodiments, the processing may include blending two or more photos (e.g. mix an ambient photo and a flash photo, etc.), creating a new generated image (e.g. based off of enhancing and/or any other action, etc.), and/or taking any other action with respect to the sent package.

As shown, after processing the one or more images at the server (and any other data sent), it is determined whether local URLs are identified. See decision **612**. In various embodiments, local URLs may be previously identified and sent by the client device. In other embodiments, local URLs may be assigned by a server. For example, in one embodiment, the server may identify a first client device as the source of the sent one or more images. In such an embodiment, the server may identify the location (e.g. on the storage medium) of the one or more images, and/or may identify simply the source (e.g. the device, etc.).

In one embodiment, if the server identifies the source and not the full location, the local URL may be incomplete (e.g. the full address to the resource may not be identified, etc.). In such an embodiment, when sending the modified package back to the client, the server may request whether the resources initially sent can be located on the client device. If so, then the server may not include such one or more images. In the event, however, that the client device cannot locate the one or more images, then the server may send the one or more images back to the client device.

As shown, if local URLs are identified, then a reduced package is sent back to the client. See operation **614**. Additionally, if local URLs are not identified, then a full package is sent back to the client. See operation **616**.

In one embodiment, a reduced package may include any data less than a full package, the full package containing all images, metadata, code (e.g. GL, etc.) necessary to enable an independent web application. In another embodiment, a reduced package may not include those resources (e.g. images, etc.) for which a local UPI was identified. In some embodiments, a reduced package may include a full package but at a lower overall data amount. For example, in one embodiment, the one or more images may be compressed in some manner to minimize data exchange. In such an embodiment, the client web application may use lower resolution photos to manipulate the photo. After manipulating the photos via the web application, the instructions as dictated by the user may be sent back to the server to create a full resolution generated image. Such a full resolution generated image may then be returned to the client (e.g. via, email, via an application, via a cloud storage service, etc.).

In the context of the present description, a local URL may include any reference to a resource stored on a local device. In one embodiment, a local URL may refer to the storage location of an image. Additionally, a local URL may refer to an object that resides within the mobile device, such as within a local file system associated with the mobile device.

FIG. **7** illustrates a method **700** for exchanging images, in accordance with another embodiment. As an option, the method **700** may be carried out in the context of the details of any of the Figures disclosed herein. Of course, however, the method **700** may be carried out in any desired environment. Further, the aforementioned definitions may equally apply to the description below.

As shown, a client **708** may include a package **702**. In one embodiment, the package **702** may include one or more images (e.g. EV−2, EV0, EV+2, etc.), metadata associated with the one or more images, metadata associated with the device (e.g. camera, mobile device, etc.), and/or any other pertinent data relating to the one or more images. In various embodiments, the package may include local URLs **704** which may provide a location for any of the resources (e.g. one or more images, metadata, etc.). The package is then sent **706** from a client **708** to a server **710**.

In one embodiment, the package may be processed **712** which may include evaluating one or more images, metadata, and/or any of the data which is sent from the client device. In another embodiment, the processing may include taking an action (e.g. blend two or more images, enhance the one or more images, etc.).

As shown, a revised image package **714** may be created. In one embodiment, the revised image package may include blending instructions, code (e.g. GL code, etc), a generated image (e.g. based on the one or more images, etc.), data necessary for a web application (e.g. full functionality web application, limited functionality web application, etc.), and/or any other information which may be associated with the one or more images.

In one embodiment, more than one revised package may be created or different revised packages may be created based on the original image package **702**. For example, a revised package may be created for a limited functionality application, for a full functionality application, for a client which has one or more resources (e.g. local URLs, images, metadata, etc.), for a mobile-version web application, for a desktop-version web application, for a reduced size package, and/or any combination of the foregoing. As such, in some embodiments, multiple versions of an image package may be created. In some embodiments, the version of the revised image package created may depend on the intended destination. For example, in one embodiment, the end destination may include a user which pays for a premium service for access to more or all of the functions and controls of the web application. In such an embodiment, a revised image package may be created such that the end destination has full access to the functions and controls of the web application. Of course, in other embodiments, any type of revised image package may be created which may be associated with the intended destination in some manner.

As shown, the revised image package may be sent **718** from the server **710** to the client **708**. Additionally, the received image package **720** may be received from the server.

In one embodiment, the received image package may not include those resources which are already provided for on the client device. For example, in various embodiments, a client device may include one or more images as well as associated metadata. As such, when the received image package is received from the server, the package may not include such resources, but only include those items which were not previously found on the client device. For example, one or more objects, resources, and/or code may have originated on the server device, and therefore would not be found on the original client device. As such, the revised image package may include those items which originated from the server device and which did not originally come from the client device. Of course, in other embodiments, the revised image package may include objects from any location (e.g. server, client, etc.).

In some embodiments, the received image package may be sent on a temporary basis to the client device. For example, in one embodiment, the received image package may be sent to the client for approval, after which the received image package may be publicly released. In other embodiments, an action may be taken (e.g. generate full resolution combined image, etc.), a full feature web application may be released (e.g. in response to being approve for premium features, etc.), and/or any other action may be taken in response to receiving feedback (e.g. approval, etc.) from the client.

FIG. **8** illustrates a method **800** for determining whether a filter is to be included a pipeline, in accordance with another embodiment. As an option, the method **800** may be implemented in the context of the details of any of the Figures disclosed herein. Of course, however, the method **800** may be implemented in any desired environment. Further, the aforementioned definitions may equally apply to the description below.

As shown, a method **800** may include identifying one or more source images. See operation **802**. It is then determined whether filter **1** is modified, whether filter **2** is modified, and/or whether filer **3** is modified. See decisions **804**, **806**, **808**. If it is determined that filter **1**, filter **2**, and/or filter **3** has been modified, then the input is sent to GL code. See object **810**. Further, after input from GL Code has concluded, or if no filter is modified, then a resulting image is created. See operation **812**.

In various embodiments, the image package **814** may be independent of other resources, such that when one or more inputs are received (e.g. a modification to filter **1**, filter **2**, filter **3**, etc.), the image package can receive such inputs and provide an output without having to fetch and/or retrieve data or code from another source.

In some embodiments, filter **1**, filter **2**, filter **3**, and/or any number of filters may relate to color modification and mapping (e.g., white balance, saturation, color selection, hue mapping, etc.), exposure, contrast, general level mapping, any sampling kernel filter, any mixing filter (e.g., of two or more input images), and/or any other parameter associated with an image. In other embodiments, an application (e.g. web application, etc.) may dictate what parameters should be applied for the filters. In one embodiment, a filter may be comprised of multiple parameters (e.g. white balance, exposure, warmth, etc.) wherein modification to one filter value may modify multiple parameters. In another embodiment, a filter may include a dehazing and/or a blurring operation.

In one embodiment, the image package **814** may be provided by a server to run locally on a client device. For example, in one embodiment, the GL code included in the image package may provide the functionality such that inputs may be received, modifications to the one or more images may occur (e.g. based on the inputs, etc.), and/or a resulting image may be created.

FIG. **9** illustrates a user interface (UI) system **900** for generating a combined image **920**, according to one embodiment of the present invention. As an option, the UI system **900** may be implemented in the context of the details of any of the Figures disclosed herein. Of course, however, the UI system **900** may be carried out in any desired environment. Further, the aforementioned definitions may equally apply to the description below.

In one embodiment, a combined image **920** comprises a combination of at least two related digital images. In one embodiment, the combined image **920** comprises, without limitation, a combined rendering of a first digital image and a second digital image. In another embodiment, the digital images used to compute the combined image **920** may be generated by amplifying an analog signal with at least two different gains, where the analog signal includes optical scene information captured based on an optical image focused on an image sensor. In yet another embodiment, the analog signal may be amplified using the at least two different gains on a pixel-by-pixel, line-by-line, or frame-by-frame basis.

In one embodiment, the UI system **900** presents a display image **910** that includes, without limitation, a combined image **920**, a slider control **930** configured to move along track **932**, and two or more indication points **940**, which may each include a visual marker displayed within display image **910**.

In one embodiment, the UI system **900** is generated by an adjustment tool executing within a processor complex **310** of a digital photographic system **300**, and the display image **910** is displayed on display unit **312**. In one embodiment, at least two digital images, such as the at least two related digital images, comprise source images for generating the combined image **920**. The at least two digital images may reside within NV memory **316**, volatile memory **318**, memory subsystem **362**, or any combination thereof. In another embodiment, the UI system **900** is generated by an adjustment tool executing within a computer system, such as a laptop computer or a desktop computer. The at least two digital images may be transmitted to the computer system or may be generated by an attached camera device. In yet another embodiment, the system **900** may be generated by a cloud-based server computer system, which may download the at least two digital images to a client browser, which may execute combining operations described below. In another embodiment, the system **900** is generated by a cloud-based server computer system, which receives the at least two digital images from a digital photographic system in a mobile device, and which may execute the combining operations described below in conjunction with generating combined image **920**.

The slider control **930** may be configured to move between two end points corresponding to indication points **940**-A and **940**-B. One or more indication points, such as indication point **940**-C may be positioned between the two end points. Each indication point **940** may be associated with a specific version of combined image **920**, or a specific combination of the at least two digital images. In one embodiment, when the slider control **930** is positioned directly over the indication point **940**-A, only the first digital image may be displayed as the combined image **920** in the display image **910**, and similarly when the slider control **930** is positioned directly over the indication point **940**-B, only the second digital image may be displayed as the combined image **920** in the display image **910**.

In one embodiment, indication point **940**-C may be associated with a blending of the first digital image and the second digital image. For example, when the slider control **930** is positioned at the indication point **940**-C, the combined image **920** may be a blend of the first digital image and the second digital image. In one embodiment, blending of the first digital image and the second digital image may comprise alpha blending, brightness blending, dynamic range blending, and/or tone mapping or other non-linear blending and mapping operations. In another embodiment, any blending of the first digital image and the second digital image may provide a new image that has a greater dynamic range or other visual characteristics that are different than either of the first image and the second image alone. Thus, a blending of the first digital image and the second digital image may provide a new computed HDR image that may be displayed as combined image **920** or used to generate combined image **920**. To this end, a first digital signal and a second digital signal may be combined, resulting in at least a portion of a HDR image. Further, one of the first digital signal and the second digital signal may be further combined with at least a portion of another digital image or digital signal. In one embodiment, the other digital image may include another HDR image.

In one embodiment, when the slider control **930** is positioned at the indication point **940**-A, the first digital image is displayed as the combined image **920**, and when the slider control **930** is positioned at the indication point **940**-B, the second digital image is displayed as the combined image **920**; furthermore, when slider control **930** is positioned at indication point **940**-C, a blended image is displayed as the combined image **920**. In such an embodiment, when the slider control **930** is positioned between the indication point **940**-A and the indication point **940**-B, a mix (e.g. blend) weight may be calculated for the first digital image and the second digital image. For the first digital image, the mix weight may be calculated as having a value of 0.0 when the slider control **930** is at indication point **940**-B and a value of 1.0 when slider control **930** is at indication point **940**-A, with a range of mix weight values between 0.0 and 1.0 located between the indication points **940**-B and **940**-A, respectively. Referencing the mix operation, the mix weight may be calculated as having a value of 0.0 when the slider control **930** is at indication point **940**-A and a value of 1.0 when slider control **930** is at indication point **940**-B, with a range of mix weight values between 0.0 and 1.0 located between the indication points **940**-A and **940**-B, respectively.

In one embodiment, a mix operation may be applied to the first digital image and the second digital image based upon at least one mix weight value associated with at least one of the first digital image and the second digital image. In one embodiment, a mix weight of 1.0 gives complete mix weight to the digital image associated with the 1.0 mix weight. In this way, a user may blend between the first digital image and the second digital image. To this end, a first digital signal and a second digital signal may be blended in response to user input. For example, sliding indicia may be displayed, and a first digital signal and a second digital signal may be blended in response to the sliding indicia being manipulated by a user.

This system of mix weights and mix operations provides a UI tool for viewing the first digital image, the second digital image, and a blended image as a gradual progression from the first digital image to the second digital image. In one embodiment, a user may save a combined image **920** corresponding to an arbitrary position of the slider control **930**. The adjustment tool implementing the UL system **900** may receive a command to save the combined image **920** via any technically feasible gesture or technique. For example, the adjustment tool may be configured to save the combined image **920** when a user gestures within the area occupied by combined image **920**. Alternatively, the adjustment tool may save the combined image **920** when a user presses, but does not otherwise move the slider control **930**. In another implementation, the adjustment tool may save the combined image **920** when a user gestures, such as by pressing a UI element (not shown), such as a save button, dedicated to receive a save command.

To this end, a slider control may be used to determine a contribution of two or more digital images to generate a final computed image, such as combined image **920**. Persons skilled in the art will recognize that the above system of mix weights and mix operations may be generalized to include two or more indication points, associated with two or more related images without departing the scope and spirit of the present invention. Such related images may comprise, without limitation, any number of digital images that have been generated using a same analog signal to have different brightness values, which may have zero interframe time.

Furthermore, a different continuous position UI control, such as a rotating knob, may be implemented rather than the slider **930** to provide mix weight input or color adjustment input from the user.

Of course, in other embodiments, other user interfaces may be used to receive input relating to selecting one or more points of interest (e.g. for focus, for metering, etc.), adjusting one or more parameters associated with the image (e.g. white balance, saturation, exposure, etc.), and/or any other input which may affect the image in some manner.

As shown, in a particular embodiment, the UI System **900** may include an indication point for cooler/more ambient **942** and/or warmer/more flash **944**. Of course, one or more indication points may be used for any parameter.

In one embodiment, the cooler/more ambient indication point **942** may control an exposure value, a white balance, a warmth (e.g. temperature, etc.), a blending priority for the ambient photo, etc. In other embodiments, the warmer, more flash indication point **944** may control an exposure value, a white balance, a warmth (e.g. temperature, etc.) a blending priority for the flash photo, etc. Of course, in one embodiment, any combination of parameters may be used and/or controlled by a single indication point.

In another embodiment, an indication point may include one or more parameters. Still yet, in one embodiment, an advanced user may expand the slider to display each parameter associated with the indication point. For example, in one embodiment, a slider may be expanded to display an individual slider associated with each parameter related to the indication point. For example, in one embodiment, an indication point may control, in combination, an exposure value, a white balance, a warmth, and a blending priority. In one embodiment, such parameters may be expanded such that an individual slider may be displayed for each of an exposure value, a white balance, a warmth, and a blending priority. In this manner, an advanced user may have fine-grain control over how parameters are implemented. Nonetheless, in some embodiments, the default settings associated with the indication (having the parameters in combination, etc.) may be associated with optimized settings (e.g. based on the type of photos, camera, date, time, etc.).

FIG. **10** is a method **1000** for generating a combined image, according to one embodiment of the present invention. As an option, the method **1000** may be carried out in the context of the details of any of the Figures disclosed herein. Of course, however, the method **1000** may be carried out in any desired environment. Further, the aforementioned definitions may equally apply to the description below.

The method **1000** begins in step **1010**, where an adjustment tool executing within a processor complex, such as processor complex **310**, loads at least two related source images, such as the first digital image and the second digital image described in the context of FIG. **9**. In step **1012**, the adjustment tool initializes a position for a UI control, such as slider control **930** of FIG. **9**, to a default setting. In one embodiment, the default setting comprises an end point, such as indication point **940**-A, for a range of values for the UI control. In another embodiment, the default setting comprises a calculated value based on one or more of the at least two related source images. In certain embodiments, the default setting is initialized to a value previously selected by a user in association with an image object comprising at least the first digital image and the second digital image.

In step **1014**, the adjustment tool generates and displays a combined image, such as combined image **920** of FIG. **9**, based on a position of the UI control and the at least two related source images. In one embodiment, generating the combined image comprises mixing the at least two related source images as described previously in FIG. **9**. In step **1016**, the adjustment tool receives user input. The user input may include, without limitation, a IA gesture such as a selection gesture or click gesture within display image **910**. If, in step **1020**, the user input should change the position of the UI control, then the adjustment tool changes the position of the UI control and the method proceeds back to step **1014**. Otherwise, the method proceeds to step **1030**.

If, in step **1030**, the user input does not comprise a command to exit, then the method proceeds to step **1040**, where the adjustment tool performs a command associated with the user input, in one embodiment, the command comprises a save command and the adjustment tool then saves the combined image, which is generated according to a position of the UI control. The method then proceeds back to step **1016**.

Returning to step **1030**, if the user input comprises a command to exit, then the method terminates in step **1090**, where the adjustment tool exits, thereby terminating execution.

Of course, in various embodiments, the adjustment tool may be used to blend one or more points of interest, one or more white-balance points, and/or any other parameter associated with the image. In some embodiments, the adjustment tool may relate to a full scene (e.g. entire image, etc.) associated with two or more images. In other embodiments, the adjustment tool may relate to a subset (e.g. a particular point(s), etc.) of the image.

FIG. **11** illustrates a color adjustment graph **1100** for altering a color associated with an image, according to one embodiment of the present invention. As an option, the color operation **1100** may be implemented in the context of the details of any of the Figures disclosed herein. Of course, however, the color operation **1100** may be implemented in any desired environment. Further, the aforementioned definitions may equally apply to the description below.

As shown, a color adjustment graph **1102** is included. The color adjustment graph **1102** may include a first color curve, green **1104**, a second color curve, blue **1106**, and a third color curve, red **1108**. Further, a cooler indication point **1110** and a warmer **1112** may be included.

In various embodiments, the color adjustment graph **1102** may relate to color adjustment, including, but not limited to, white balance, warming/cooling, saturation, temperature, color scheme (e.g. b&w, sepia, etc.), selective color schemes (e.g. only display color red, etc.), etc. In one embodiment, the horizontal axis may represent a color adjustment value. Additionally, as shown in one embodiment, as the color adjustment values decrease, the color tone warms (more red, less blue), whereas as the color adjustment values increase, the color tone cools (more blue, less red). In one embodiment, blue and red values may intersect horizontally directly in the middle of the color adjustment graph.

In one embodiment, the vertical axis represents color adjustment values associated with red, green, and blue. The horizontal axis may represent an input value, such as a value corresponding to a position of slider control **930**. A red curve **1108** represents a red adjustment value (Cr), a green curve **1104** represents a green adjustment value (Cg), and the blue curve **1106** represents a blue adjustment value (Cb). As shown, Cr is reduced as the input value ranges towards a cooler direction **1110**, while Cb is reduced as the input value ranges towards the warmer direction **1112**. Each color channel (red, greed, blue) of each pixel within an image may be multiplied by a corresponding adjustment value (Cr, Cg, Cb) to yield a color-adjusted image. A cooler color-adjusted image is produced when the user input ranges towards the cooler direction **1110**, while a warmer color-adjusted image is produced when the user input ranges towards the warmer direction **1112**.

FIG. **1** illustrates a user interface (UI) **1200** for a first user, according to one embodiment of the present invention. As an option, the UI **1200** may be implemented in the context of the details of any of the Figures disclosed herein. Of course, however, the UI **1200** may be implemented in any desired environment. Further, the aforementioned definitions may equally apply to the description below.

As shown, user interface **1200** may include a user identification **1202**, a resulting image **1204**, source image(s) selection **1206**, color scheme(s) selection **1208**, slider **1210**, slider control **1212**, a first indication point **1214**, a second indication point **1218**, a middle indication point **1216**, and filter(s) selection **1220**.

In one embodiment, the user interface **1200** may be presented for a first user, including, for example, a paying user, for premium access, and/or a for a full feature web application, etc. In various embodiments, such an user interface may be adapted for mobile use and/or desktop use.

In various embodiments, a user identification may include any identification relating to a user, including a name, a username, an account id, and/or any other identification. In one embodiment, a resulting image may include a generated image (e.g. from a server, based on modifications from one or more inputs, etc.), a blended image (e.g. from two or more images, etc.), and/or any other image associated with an image package.

In one embodiment, source image(s) selection may include the ability to select which images are used as the basis for processing (e.g. mixing, blending, etc). For example, in one embodiment, a first image may be an ambient image, and the second and third images may be flash images. The user may select to only include one of the two flash images.

In various embodiments, color scheme may include RGB, grayscale, CMYK, and/or a custom color scheme. Of course, in other embodiments, any color scheme may be included. Additionally, in one embodiment, the slider may be associated with a filter. For example, in one embodiment, a filter may include exposure, focus, warmth, contrast, saturation, blending, gain, and/or color. Of course, in other embodiments, a filter may include other parameters associated with manipulating and/or adjusting the image. Based off of the selection of the filter, the slider may adjust and/or change accordingly. In one embodiment, a selection of warmth may cause a slider to display "cooler" to one side and "warmer" to the other side.

In another embodiment, selection of a filter may cause modification of multiple parameters. For example, in one embodiment, a selection of warmth may cause a slider to display "cooler" and/or "more ambient" on one side and "warmer" and/or "more flash" to the other. Of course, any parameters in combination may be used and manipulated by a single slider. In another embodiment, if multiple parameters are controlled by a single slider, an option may be presented to display multiple sliders, one for each parameter which is being controlled in combination.

FIG. **13** illustrates a user interface (UI) **1300** for a second user, according to one embodiment of the present invention. As an option, the UI **1300** may be implemented in the context of the details of any of the Figures disclosed herein. Of course, however, the UI **1300** may be implemented in any desired environment. Further, the aforementioned definitions may equally apply to the description below.

As shown, user interface **1300** may include a user identification **1302**, a resulting image **1304**, source image(s) selection **1306**, color scheme(s) selection **1308**, slider **1310**, slider control **1312**, a first indication point **1314**, a second indication point **1318**, a middle indication point **1316**, and filter(s) selection **1320**.

In one embodiment, the user interface **1300** may be presented for a second user, including, for example, a non-paying user, for free access, and/or for a limited feature web application, etc. In various embodiments, such a user interface may be adapted for mobile use and/or desktop use. As shown, one or more features may be disabled due to the user interface **1300** being of limited features. For example, source image(s) selection, color scheme(s) selection, and filter(s) selection may indicate "Not available without premium access."

In one embodiment, the slider may alter one or more parameters associated with the image. In another embodiment, the slider may alter the warmth and/or control the blending associated with an image. As an example, the slider may display "cooler" and "more ambient" to one side and "warmer" and "more flash" to the other side. Additionally, in one embodiment, because the user interface is of limited functionality, the user may not have the ability to separate the slider into separate sliders fir each of the parameters included in the general slider (unlike the full functionality application which may do so). Of course, however, in other embodiments, any of the functionality of the limited feature application may be restricted in any manner. In one embodiment, such restrictions may be defined in the image package sent from the server.

One advantage of the present invention is that a digital photograph may be selectively generated based on user input using two or more different exposures of a single capture of a photographic scene. Accordingly, the digital photograph generated based on the user input may have a greater dynamic range than any of the individual exposures.

Traditional techniques for generating a HDR photograph involve significant computational resources, as well as produce artifacts which reduce the image quality of the resulting image. Accordingly, strictly as an option, one or more of the above issues may or may not be addressed utilizing one or more of the techniques disclosed herein.

Still yet, in various embodiments, one or more of the techniques disclosed herein may be applied to a variety of markets and/or products. For example, although the techniques have been disclosed in reference to a photo capture, they may be applied to televisions, web conferencing (or live streaming capabilities, etc.), security cameras (e.g. increase contrast to determine characteristic, etc.), automobiles (e.g. driver assist systems, in-car infotainment systems, etc.), and/or any other product which includes a camera input.

While various embodiments have been described above, it should be understood that they have been presented by way of example only, and not limitation. Thus, the breadth and scope of a preferred embodiment should not be limited by any of the above-described exemplary embodiments, but should be defined only in accordance with the following claims and their equivalents.

What is claimed is:

1. An apparatus, comprising:

a server for:

receiving one or more images;

analyzing the one or more images;

creating or receiving one or more combined images based on the one or more images;

receiving at least one filter associated with the at least one of: the one or more images and the one or more combined images;

creating a specification referencing at least two of:

the one or more images,

the one or more combined images, and

the at least one filter associated with the at least one of: the one or more images and the one or more combined images; and

outputting image processing code referencing the specification;

wherein when at least one of the one or more images was generated using a strobe unit to generate strobe illumination, then the outputting includes at least one of:

providing access to code created for rendering vector graphics in a web application,

providing access to a created resulting image which references one or more assets not stored on the server, and

providing access to code created for manipulating the one or more images, wherein the one or more images includes at least one ambient image and at least one strobe image.

2. The apparatus of claim 1, wherein the apparatus is operable such that the analyzing includes at least one of creating a high dynamic range (HDR) image, and processing the one or more images.

3. The apparatus of claim 1, wherein the apparatus is operable such that the image processing code includes the one or more images.

4. The apparatus of claim 1, wherein the apparatus is operable such that the outputting includes at least one of providing access to the web application associated with the one or more images, and pushing the web application associated with the one or more images to a recipient.

5. The apparatus of claim 4, wherein the apparatus is operable such that sliding indicia is displayed utilizing the web application and the one or more images are blended based on a first aspect, in response to the sliding indicia being manipulated by a user.

6. The apparatus of claim 5, wherein the apparatus is operable such that the first aspect includes at least one of a white balance, a focus, an exposure, a color correction, or an intensity.

7. The apparatus of claim 1, wherein the apparatus is operable such that the outputting includes providing access to the created resulting image which references the one or more assets not stored on the server, and the apparatus is further operable such that the one or more assets are stored locally on a mobile device.

8. The apparatus of claim 7, wherein the apparatus is operable such that the image processing code references the one or more assets stored locally on the mobile device, as well as the resulting image which is stored on the server.

9. The apparatus of claim 1, wherein the apparatus is operable for generating the resulting image based on the one or more images, the resulting image being stored on the server.

10. The apparatus of claim 1, wherein the apparatus is operable for constructing two or more versions of the web application associated with the one or more images.

11. The apparatus of claim 10, wherein the apparatus is operable such that at least one of the two or more versions is associated with a paying account.

12. The apparatus of claim 11, wherein the apparatus is operable such that the paying account is associated with a user identifier or a user account.

13. The apparatus of claim 10, wherein the apparatus is operable such that at least one of the two or more versions is associated with a free account.

14. The apparatus of claim 10, wherein the apparatus is operable such that each version of the web application provides a different set of features, at least in part, by which the one or more images are capable of being manipulated utilizing the web application.

15. The apparatus of claim 1, wherein the apparatus is operable such that analyzing the one or more images includes at least one of correcting white balance, correcting exposure levels, creating a high dynamic range (HDR) image, setting a black point, setting a white point, performing a dehaze function, and adjusting a HDR strength.

16. The apparatus of claim 15, wherein the apparatus is operable such that analyzing the one or more images includes setting the black point, and the apparatus is further operable such that the black point is capable of being adjusted based on input by a user.

17. The apparatus of claim 15, wherein the apparatus is operable such that analyzing the one or more images includes setting the white point, and the apparatus is further operable such that the white point is capable of being adjusted based on input by a user.

18. A computer program product embodied on a non-transitory computer readable medium, comprising:
- code for receiving one or more images at a server;
- code for analyzing the one or more images;
- code for creating or receiving one or more combined images based on the one or more images;
- code for receiving at least one filter associated with the at least one of: the one or more images and the one or more combined images;
- code for creating a specification referencing at least two of:
  - the one or more images,
  - the one or more combined images, and
  - the at least one filter associated with the at least one of: the one or more images and the one or more combined images; and
- code for outputting image processing code referencing the specification;
- wherein when at least one of the one or more images was generated using a strobe unit to generate strobe illumination, then the code for outputting includes at least one of:
  - code for providing access to code created for rendering vector graphics in a web application,
  - code for providing access to a created resulting image which references one or more assets not stored on the server, and
  - code for providing access to code created for manipulating the one or more images, wherein the one or more images includes at least one ambient image and at least one strobe image.

19. A method, comprising:
- receiving one or more images at a server;
- analyzing the one or more images;
- creating or receiving one or more combined images based on the one or more images;
- receiving at least one filter associated with the at least one of: the one or more images and the one or more combined images;
- creating a specification referencing at least two of:
  - the one or more images,
  - the one or more combined images, and
  - the at least one filter associated with the at least one of: the one or more images and the one or more combined images; and
- outputting image processing code referencing the specification;
- wherein when at least one of the one or more images was generated using a strobe unit to generate strobe illumination, then the outputting includes at least one of:
  - providing access to code created for rendering vector graphics in a web application,
  - providing access to a created resulting image which references one or more assets not stored on the server, and
  - providing access to code created for manipulating the one or more images, wherein the one or more images includes at least one ambient image and at least one strobe image.

20. The apparatus of claim 1, wherein the apparatus is further operable such that the server receives at least one feedback associated with the image processing code, and modifies the image processing code based on the at least one feedback.

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